Comments of

COALITION FOR SAFE BUILDING MATERIALS

(California Pipe Trades Council, California Firefighters Association, Consumer Federation of California, Planning and Conservation League, Center for Environmental Health, Sierra Club of California and Communities for a Better Environment)

on the

ADDENDUM TO ADOPTED MITIGATED NEGATIVE DECLARATION
STATE CLEARINGHOUSE NO. 2000091089
FOR
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE
USE FOR POTABLE WATER PIPING IN RESIDENTIAL BUILDINGS

VOLUME II

APPENDICES TO THE COMMENTS OF
ADAMS BROADWELL JOSEPH & CARDOZO

April 22, 2005

1

STATE OF CALIFORNIA - BUSINESS, T NSPORTATION AND HOUSING AGENCY GRAY DAVIS, Governor
DEPARTMENT OF HOUSING AND ' MMUNITY DEVELOPMENT
Division of Legal Affairs
1800 Third Street, Suite 440
P.O. Box 952052
Sacramento, CA 94252-2052
(916) 323-7288
FAX (916) 322-2815

September 21, 2000

Ms. Terry Roberts
State Clearinghouse
Office of Planning and Research
1400 Tenth Street
Sacramento, CA 95814

Re: Draft Negative Declaration with Mitigation Measures for the Limited Use of Chlorinated Polyvinyl Chloride (CPVC) Pipe for Potable Water Piping in Residential Buildings

Dear Ms. Roberts:

The California Department of Housing and Community Development has prepared a Draft Negative Declaration with Mitigation Measures to consider the adoption of regulations into Title 24, California Plumbing Code. These regulations are for statewide application and would expand the use of Chlorinated Polyvinyl Chloride (CPVC) pipe as an alternative material in residential buildings. CPVC pipe will be allowed for potable water piping only in those situations where the local building official has made a determination that there is or will be the premature failure of metallic pipe and subject to compliance with the mitigation measures.

The review period for the Draft Negative Declaration will be from September 26, 2000 to November 6, 2000. As required by the Public Resources Code and the State Clearinghouse, please find enclosed the Notice of Completion Form and 15 copies of the draft Negative Declaration.

If you have any questions or comments, please contact me at (916) 323-7288.

Sincerely,

William J. Staack

William J. Staack, Esq. P.E.
Staff Counsel

Enclosures

STATE OF CALIFORNIA -BUSINESS, TRANSI ,ATION AND HOUSING AGENCY GRAY DAVIS, Governor

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
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PUBLIC NOTICE

NOTICE OF AVAILABILITY
for the
DRAFT NEGATIVE DECLARATION WITH MITIGATION MEASURES FOR PROPOSED CPVC REGULATIONS

and

PUBLIC COMMENT PERIOD

The California Department of Housing and Community Development, invites public comments on a Draft Negative Declaration with Mitigation Measures.

Project Description: The project considered in the Draft Negative Declaration is a proposed regulation by the Department of Housing and Community Development (HCD) and consists of the adoption of specified code language into the Tile 24 of the California Plumbing Code. The regulation would authorize local building officials to approve chlorinated polyvinyl chloride (CPVC) pipe as an alternate material for hot and cold-water distribution systems within residential structures under limited circumstances and subject to specified conditions and mitigation measures. HCD is authorized to propose building standards applicable to certain residential occupancies. (Health & Saf. Code section 17921.) The building standards proposed by HCD are submitted to the California Building Standards Commission for final adoption. (Health & Saf. Code section 18930.)

If adopted, the proposed building standards regulations would grant local building officials the authority to approve the use of CPVC pipe for water distribution systems within residential buildings in accordance with the California Plumbing Code procedures for approving alternate materials and subject to conditions and mitigation measures that are incorporated into the regulatory proposal.

Draft Negative Declaration with Mitigation Measures:
Department of Housing and Community Development (HCD) has prepared an Initial Study, in compliance with the California Environmental Quality Act (CEQA). The Initial Study analyzes the potential environmental impacts associated with the adoption of the proposed regulations into Title 24 of the California Plumbing Code. The Initial Study finds that if adopted with the specified mitigation measures and with the limited scope of application in residential buildings (i.e., where it is determined by the local building official that there is or will be the premature failure of metallic pipe) the proposed project would not have a significant negative impact on the

environment. As a result HCD is proposing to adopt a Negative Declaration with Mitigation measures for this project.

Satisfy Court Ordered Requirement:
This regulatory proposal and Negative Declaration are being prepared pursuant to an agreement to settle a lawsuit challenging an Environmental Impact Report (EIR) that had been certified by HCD with regard to a previous HCD proposal to approve CPVC for statewide use. This settlement agreement provides for recision of the prior EIR certification and withdrawal of the proposed regulations approving CPVC on a statewide basis. In addition to the conditions and mitigation measures described above, the settlement agreement provides that HCD will issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. The settlement agreement also provides for HCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Location:
Residential Occupancy Buildings where the local building official determines that there is or will be the premature failure of metallic pipe, Statewide.

Starting And Ending Dates For Review Period:
September 26, 2000 through November 6, 2000.

Lead Agency
California Department of Housing and Community Development, Legal Affairs Division.

Address Where Copies Of Proposed Negative Declaration Is Available:
A copy of the Draft Negative Declaration my be inspected by members of the public at the office of the Lead Agency, the California Department of Housing and Community Development at Room 440, 1800 Third Street, Sacramento, California. The document is also available on the Web at: http://www.hcd.ca.gov/.

Contact Person:
Bill Staack, (916) 323-7288

SETTLEMENT AGREEMENT

This Settlement Agreement ("Agreement") is made as of September 14, 2000, by and between Richard Cuffe, Greg Baker, Ron Morgan, Sam Gill, California Pipe Trades Council, California Professional Firefighters Association, California Legislative Conference of the Plumbing, Heating and Piping Industry, and Mechanical Contractors Association of Northern California (collectively "Petitioners"), and California Department of Housing and Community Development ("HCD") and B. F. Goodrich Company, Inc., its predecessors, successors, and past and present subsidiaries and affiliates ("Goodrich"). Petitioners, HCD and Goodrich are sometimes each referred to as a "Party" and collectively referred to as "Parties."

RECITALS

This Agreement is entered into on the basis of the following facts, understandings and intentions of the Parties:

1. On December 1, 1998, HCD certified an environmental impact report (the "EIR") and issued a Notice of Determination (the "NOD") pursuant to the California Environmental Quality Act ("CEQA") respecting its proposal to approve and submit to the California Building Standards Commission (the "Commission") proposed regulations that would permit the use of CPVC (chlorinated polyvinyl chloride) water supply plumbing materials in residential occupancies subject to HCD regulatory authority. On December 4, 1998, the HCD approved the proposed regulations and filed them with the Commission.

2. On December 30, 1998, Petitioners filed a Petition for Writ of Mandate in San Francisco Superior Court styled *Cuffe, et al. v. California Department Of Housing And Community Development*, San Francisco Superior Court Case No. 300221 (the "CPVC Action"), claiming that HCD had failed to comply with various legal requirements of CEQA and seeking a writ of mandate requiring HCD to rescind its certification of the EIR and its approval of the proposed regulations and withdraw from consideration by the Commission its submittal of the proposed regulations.

3. Without admitting the validity or invalidity of any claim made by Petitioners in the CPVC Action, or of any defense to the CPVC Action available to HCD and/or Goodrich, the Parties have entered into this Agreement.

AGREEMENT

In consideration of the mutual benefits of this Agreement, and for other good and valuable consideration, the Parties agree as follows:

A. Recitals.

The foregoing recitals are true and correct and are incorporated here by this reference.

B. Incorporation of Letter of Settlement Terms.

The parties hereby incorporate by reference in its entirety the Letter of Settlement Terms signed by the Parties between June 14 and July 12, 2000, including the Mitigation Measures attached as Exhibit A to that Letter of Settlement Terms. A copy of the Letter of Settlement Terms and Exhibit A thereto is attached to this Agreement as Exhibit A.

C. Additional Obligations Of The Parties.

Each Party agrees to be bound by the Letter of Settlement Terms and the Mitigation Measures, to the extent that they apply to that Party.

D. Joint Submission of Agreement for Court Approval; Dismissal of Action.

Promptly upon executing this Agreement, the Parties will jointly submit to the Court in the CPVC Action a copy of this Agreement for the Court's approval. Within five (5) business days after obtaining the Court's approval, Petitioners, and each of them, shall dismiss with prejudice the CPVC Action.

E. No Intent to Create Third Party Beneficiaries.

The Parties intend that the rights and obligations under this Agreement shall benefit and burden only the Parties and their successors and do not intend to create any rights in any third Parties who are not signatories to this Agreement.

F. No Waiver.

The failure of any Party to insist upon strict adherence to any term of this Agreement on any occasion shall not be deemed a waiver or deprive that Party of the right thereafter to insist upon strict adherence to that term or any other term of this Agreement. Any waiver must be in a writing signed by the Party granting the waiver.

G. Acknowledgements and Warranties.

1. The Parties acknowledge they have been represented by independent legal counsel throughout the negotiations culminating in the execution of this Agreement. The Parties further acknowledge they have been fully advised by their attorneys with respect to their rights and obligations under this Agreement and understand those rights and obligations. The Parties also acknowledge that prior to the execution of this Agreement, they and their legal counsel have had an adequate opportunity to make whatever investigation or inquiries were deemed necessary or desirable with respect to the subject matter of this Agreement.

2. The Parties acknowledge that the consideration recited in this Agreement is the sole and only consideration for this Agreement and that they have voluntarily entered into this Agreement and that no representations, promises or inducements have been made other than those that appear in this Agreement.

H. Applicable Law.

This Agreement shall be construed and enforced pursuant to the laws of the State of California.

I. Entire Agreement.

This Agreement, including Exhibit A, contains the Parties' entire agreement on the matters addressed in this document.

J. Execution of the Agreement.

The persons executing this Agreement represent and warrant that they are authorized to sign on behalf of themselves and their respective principals, and that this Agreement shall be binding upon them and their respective principals. This Agreement has been fully negotiated at arm's length between the Parties after full and complete advice by independent counsel and other representatives of each Party freely chosen by it. Each Party is fully and completely informed with respect to all of the terms, covenants and conditions contained in this Agreement, and the meaning and effect thereof, and after such advice and counsel, each Party has freely and voluntarily entered into this Agreement with such full knowledge. Based on the foregoing, neither Party shall be deemed the scrivener of this Agreement, and the provisions of this Agreement shall be construed as a whole according to their common meaning – and not strictly for or against either Party – to effectuate the intent of the Parties.

K. Duplicates and Counterparts.

This Agreement may be executed in duplicate originals, each of which shall be equally admissible in evidence. This Agreement may be executed in counterparts, which when collectively executed by all of the Parties will constitute a single agreement.

L. Documents Necessary to Carry Out Agreement.

The Parties shall without delay execute any and all documents that may be necessary to carry out the provisions of this Agreement.

Dated: September ___, 2000	Richard Cuffe By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	Greg Baker By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	Ron Morgan By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	Sam Gill By: _____ (Print Name): _____ Title: _____

Dated: September ___, 2000	California Pipe Trades Council By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	California Professional Firefighters Association By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	California Legislative Conference of Plumbing, Heating and Piping Industry By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	Mechanical Contractors Association of Northern California By: _____ (Print Name): _____ Title: _____

Dated: September ___, 2000	California Department of Housing Community Development By: _____ (Print Name): _____ Title: _____
Dated: September ___, 2000	B.F. Goodrich Company, Inc. By: _____ (Print Name): _____ Title: _____

Exhibit A

Letter of Settlement Terms

The purpose of this letter, by and between the California Department of Housing and Community Development (HCD) and the California Pipe Trades Council (PTC), is to set forth the general terms for a resolution of issues related to HCD's proposed approval of the use of Chlorinated Polyvinyl Chloride (CPVC) plumbing materials for the interior distribution of potable water in residential structures.

1. HCD and PTC agree that this agreement sets forth the terms of resolution in general and that specific details are to be discussed and included in a formal Settlement Agreement that will be presented to the court for approval. In doing so, PTC acknowledges that HCD, as a public entity, cannot by agreement predetermine the outcome of a future California Environmental Quality Act (CEQA) or regulatory process and that any specific terms of this letter that may be proposed as regulations are constitutionally and statutorily subject to change pursuant to the public participation requirements inherent in the rulemaking process.

2. HCD agrees that upon execution of the settlement agreement, and the approval of that agreement by the court, it will immediately withdraw its proposed regulations to approve CPVC plumbing materials for statewide residential use (the "project") from consideration by the California Building Standards Commission (CBSC) and rescind its Notice of Determination for the project. HCD also will rescind its certification of the CPVC Environmental Impact Report issued by HCD on December 1, 1998 (the "EIR"), State Clearinghouse No. 970820040. By this agreement, the parties will deem the EIR to be "incomplete."

3. HCD will prepare and submit a regulatory proposal to the CBSC that would permit the local responsible building official to authorize use of CPVC plumbing materials as an alternative building material for interior water distribution in residential structures where the local responsible building official determines there is or will be the premature failure of metallic pipe if installed in such residential structures due to existing water or soil conditions. Any such local approval of CPVC as an alternate material shall be conditioned on compliance with the mitigation measures set forth in Exhibit A (the "mitigation measures") which will be contained in the adopted regulations. Prior to submittal of such a regulatory proposal, HCD will comply with the requirements of CEQA as described in paragraph 4 below.

4. HCD and PTC agree that based on the information currently available, a Negative Declaration is the appropriate level of CEQA compliance for such a regulatory proposal described in paragraph 3, above. PTC agrees that it will file no objection to such Negative Declaration issued by HCD, will not challenge the validity of such Negative Declaration in any court of competent jurisdiction, and will not support nor encourage in any fashion the objection or challenge to the Negative Declaration by any other party.

5. PTC agrees that in the event there is a successful judicial challenge to the Negative Declaration HCD may comply with CEQA in the manner ordered by the court and that the manufacturers of CPVC may submit information and comments in any format to assist HCD in such efforts. PTC agrees that it will not raise as an objection, in any forum, the submission of such information or comments provided that HCD subjects such submissions to its own independent review and evaluation and exercises its independent judgment in evaluating such materials and in its final CEQA determinations.

6. HCD and PTC agree that they will support the formal adoption of the mitigation measures contained in Exhibit A through the regulatory process, although HCD cannot assure that regulations proposed by HCD will not be modified as the result of reasonable public comment. PTC agrees that modifications to the mitigation measures which the PTC determines, in the exercise of its reasonable judgment, do not substantially reduce the level of protection afforded consumers and workers by the worker or consumer safety measures contained in Exhibit A, will not be deemed a breach of the settlement agreement nor serve as a basis for the repudiation of this settlement.

7. HCD agrees that it will send an information bulletin to local building officials informing them of the adoption of the regulations authorizing them to approve CPVC as an alternative building material upon a determination of metallic pipe failure, and informing them of the specific mitigation measures required for such CPVC approvals. HCD also agrees that it will from time to time, monitor the implementation of mitigation measures as adopted. Further, HCD and PTC agree that nothing in this Settlement Agreement affects, or is intended to affect any future action by the State related to the possible approval of CPVC on a statewide basis.

8. PTC agrees that upon execution of the settlement agreement and approval of the court it will dismiss the suit. The parties agree that each side will bear its own costs of the litigation and attorney fees.

9. The above terms reflect all agreements made between HCD and PTC.

Julie Bornstein, Director
California Department of Housing
And Community Development

7/12/00
Date

Joe Winstead, Executive Director
California Pipe Trades Council

6/14/00
Date

for ADK

Anthony D. Konkoly
Senior Corporate Counsel
B.F. Goodrich Company

6/23/00
Date

Exhibit A
Mitigation Measures

(a) Only CPVC piping that is listed as an approved material in, and installed in accordance with, the California Plumbing Code, may be used.
(b) The local responsible building official authorizing the use of CPVC in accordance with the California Plumbing Code shall require as part of the permitting process that the contractor, or the appropriate plumbing subcontractors, provide the written certification required in subdivision (e) and that he or she will comply with the flushing procedures and worker safety measures set forth in subdivisions (c) and (d).
(c) All installations of CPVC pipe shall be flushed twice over a period of at least one week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. At the time of the first fill, each fixture shall have a removable tag applied stating:

> "This new plumbing system was first filled on (date) by (name). The California Department of Housing and Community Development requires that the system be flushed after standing at least one week after the fill date specified above. If the system is used earlier than one week after the fill date, the water *must* be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to flushing, except by the homeowner."

(d) the following worker safety measures must be complied with during all installations of CPVC.

(1) Mechanical ventilation sufficient to maintain exposures below the relevant exposure limits established by state regulations shall be provided in enclosed spaces. This ventilation shall be directed at the breathing zone of the worker installing the pipe. Where mechanical ventilation is not practical, respirators, suitable for organic vapors, shall be used. For the purposes of this subdivision, an enclosed space is defined as:

(A) A space less than 100 square feet of floor area under a ceiling with a height of 10 feet or less, and which does not have openings (consisting of doors, windows, or unfinished walls) on at least two sides;

(B) Crawl spaces having a height of less than three feet;

(C) Enclosed attics that have a roof and ceiling; or

(D) Trenches having a depth greater than twenty-four inches.

(2) Installers of CPVC shall use non-latex thin gauge (4 millimeter) nitrile gloves, or other gloves providing an equivalent or better degree of protection during the installation of CPVC plumbing systems. Gloves shall

be provided to all workers by the contractor, or plumbing subcontractor, and shall be replaced upon contamination by cements.

(e) HCD shall request that the Department of Industrial Relations develop, within ninety (90) days of the date of the final settlement agreement guidelines describing adequate worker safety training for CPVC plumbing installations. The guidelines will include initial training of two hours for each worker and refresher training of 15 minutes, which may be provided on the worksite, at least each calendar quarter. The guidelines will be developed in consultation with HCD, PTC, and CPVC pipe manufacturers. Any contractor applying for a building permit that includes CPVC plumbing installation shall certify in writing that:

(1) They are aware of the health and safety hazards associated with CPVC plumbing installations:

(2) They have included in their Illness and Injury Prevention Plan the hazards associated with CPVC plumbing pipe installations; and

(3) The worker safety training elements of their Injury and Illness Prevention Plan meets the Department of Industrial Relation's guidelines.

(f) A local building official shall not give final approval of any CPVC plumbing installation unless it finds that the material has been installed in compliance with the requirements of the California Plumbing Code and that the installer has either complied with the complete flushing requirements of subdivision (d) or that the removable tags provided in subdivision (c) are in place. In addition, if during the conduct of any building inspection the local building official finds that the worker safety provisions of this section are being violated, he or she shall cite the installer for that violation.

(g) Any contractor or subcontractor failing to comply with the ventilation, glove or flushing requirements of this section shall be subject to fines in accordance with applicable law or regulation.

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
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DRAFT NEGATIVE DECLARATION WITH MITIGATION MEASURES for REGULATIONS FOR LIMITED USE OF CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AS POTABLE WATER PIPING IN RESIDENTIAL BUILDINGS

Project Proponent:
Department of Housing and Community Development
1800 Third Street, Suite 440
P.O. Box 952052
Sacramento, ca 94252-2052

Contact: Bill Staack

Project Description:
The project under review in this Initial Study is an amendment to the California Plumbing Code proposed by the Department of Housing and Community Development (HCD) that would authorize local building officials to approve chlorinated polyvinyl chloride (CPVC) pipe as an alternate material for hot and cold water distribution systems within residential structures under limited circumstances and subject to specified conditions and mitigation measures. HCD is authorized to propose building standards applicable to certain residential occupancies. (Health & Saf. Code section 17921.) The building standards proposed by HCD are submitted to the California Building Standards Commission for final adoption. (Health & Saf. Code section 18930.)

If adopted, the proposed building standards regulations would grant local building officials the authority to approve the use of CPVC pipe for water distribution systems within residential buildings subject to conditions and mitigation measures that are incorporated into the regulatory proposal. The full text of the proposed California Plumbing Code amendments comprising the regulatory proposal is attached.

The following specific conditions would apply to the local approvals of CPVC and would be set forth in a new section 604.1b of the California Plumbing Code. First, a local building official would be authorized to approve the use of CPVC only if he or she first determines that there is or will be a premature failure of metallic pipe if installed in such residential structures due to existing water or soil conditions. Second, any building permit issued by the local building official authorizing the use of CPVC based on such a finding would be conditioned on compliance with specific mitigation measures described below. Third, only CPVC plumbing

material listed as an approved material and installed in accordance with the California Plumbing Code could be used. Fourth, any installation and use of CPVC plumbing material pursuant to this local authorization would be required to comply with all applicable requirements of the California Plumbing Code and specific Installation Standards. Fifth, prior to issuing a building permit authorizing use of CPVC, the building official must require that any contractor or subcontractor provide written certification that such contractor or subcontractor: 1) is aware of the health and safety hazards associated with CPVC plumbing installations, has included the hazards associated with CPVC in its Illness and Injury Prevention Plan, and has included worker safety training elements in its Injury Prevention Plan that meet the guidelines of the Department of Industrial Relations; and 2) will comply with the flushing procedures and worker safety measures required as a part of these regulations. Sixth, the building official would not be authorized to give final permit approval to the installation of any CPVC plumbing materials unless he or she finds that the material has been installed in compliance with the requirements of the California Plumbing Code and specified Installation Standards. Seventh, any contractor or subcontractor found to have failed to comply with the mitigation requirements imposed by these regulations would be subject to penalties set forth in Health and Safety Code sections 17955 et seq. Finally, if during the conduct of any building inspection the building official found that the worker safety requirements imposed by these regulations were being violated, the building official would be required to cite that contractor or subcontractor for such violation.

The regulatory proposal also incorporates the following specific mitigation measures that would be adopted in a new section 301.0 of Appendix I Installation Standards of the California Plumbing Code:

301.0.1 Flushing Procedures.

301.0.1.1 All installations of CPVC pipe within residential structures shall be flushed twice over a period of at least one week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. At the time of the fill, each fixture shall have a removable tag applied stating:

"This new plumbing system was first filled on (date) by (name). The California Department of Housing and Community Development requires that the system be flushed after standing at least one week after the fill date specified above. If the system is used earlier than one week after the fill date, the water must be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to flushing, except by the homeowner."

301.0.2 Worker Safety Measures.

301.0.2.1 Mechanical ventilation sufficient to maintain exposures below the relevant exposure limits established by state regulations shall be provided in enclosed spaces. This ventilation shall be directed at the breathing zone of the worker installing the pipe. Where mechanical ventilation is not practical, respirators, suitable for organic vapors, shall be used. For the purpose of this subdivision, and enclosed space is defined as:

(a) A space less than 100 square feet of floor area under a ceiling with a height of 10 feet or less, and which does not have openings (consisting of doors, windows, or unfinished walls) on at least two sides;
(b) Crawl spaces having a height of less than three feet;
(c) Enclosed attics that have a roof and ceiling; or
(e) Trenches having a depth greater than twenty-four inches.

3.01.0.2.2 Installers of CPVC pipe within residential structures shall use non-latex thin gauge (4 millimeters) nitrile gloves, or other gloves providing an equivalent or better degree of protection during the installation of the CPVC plumbing system. Gloves shall be provided to all workers by the contractor, or plumbing subcontractor, and shall be replaced upon contamination by cements.

This regulatory proposal and Negative Declaration are also being prepared pursuant to an agreement to settle a lawsuit challenging an Environmental Impact Report (EIR) that had been certified by HCD with regard to a previous HCD proposal to approve CPVC for statewide use. This settlement agreement provides for rescission of the prior EIR certification and withdrawal of the proposed regulations approving CPVC on a statewide basis. In addition to the conditions and mitigation measures described above, the settlement agreement provides that HCD will issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. The settlement agreement also provides for HCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Because the local CPVC approval authority that would be granted by the proposed regulations requires findings of existing or expected metallic pipe failure due to existing soil and water conditions, the potential scope of CPVC use that will result from the proposed project will be limited. Information in the record of previous HCD examinations of CPVC pipe indicates that corrosive drinking water is not a widespread problem in California. The evidence before the Lead Agency indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. Finally, no cities or counties have filed with HCD modifications or changes in California Plumbing Code provisions to approve CPVC pipe pursuant to Health and Safety Code section 17958.7. For these reasons, the Lead Agency has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

Project Location:
Residential Occupancy buildings where the local building official determines that there is or will be the premature failure of metallic pipe.

Findings of No Significant Effect on Environment:
The proposed project will not have a potentially significant impact on the environment. The Initial Study, which supports this finding, is attached.

Mitigation Measures:
See Above Project Description.

STATE OF CALIFORNIA -BUSINESS, TRANSPORTATION AND HOUSING AGENCY GRAY DAVIS, Governor
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INITIAL STUDY

For the proposed adoption of regulations (building standards) into Title 24, California Plumbing Code, for the limited use of chlorinated polyvinyl chloride (CPVC) in residential buildings, where the local building official has made a determination that there is or will be the premature failure of metallic pipe and the pipe is installed pursuant to specified mitigation measures.

Lead Agency: Department of Housing and Community Development

September 2000

Prepared by:

Bill Staack, Esq., P.E.
Staff Counsel
California Department of Housing and Community Development
1800 Third Street, Suite 440
Sacramento, CA 95814
(916) 323-7288

PROJECT DESCRIPTION

The project under review in this Initial Study is an amendment to the California Plumbing Code proposed by the Department of Housing and Community Development (HCD) that would authorize local building officials to approve chlorinated polyvinyl chloride (CPVC) pipe as an alternate material for hot and cold water distribution systems within residential structures under limited circumstances and subject to specified conditions and mitigation measures. HCD is authorized to propose building standards applicable to certain residential occupancies. (Health & Saf. Code section 17921.) The building standards proposed by HCD are submitted to the California Building Standards Commission for final adoption. (Health & Saf. Code section 18930.)

If adopted, the proposed building standards regulations would grant local building officials the authority to approve the use of CPVC pipe for water distribution systems within residential buildings subject to conditions and mitigation measures that are incorporated into the regulatory proposal. The full text of the proposed California Plumbing Code amendments comprising the regulatory proposal is attached.

The following specific conditions would apply to the local approvals of CPVC and would be set forth in a new section 604.1b of the California Plumbing Code. First, a local building official would be authorized to approve the use of CPVC only if he or she first determines that there is or will be a premature failure of metallic pipe if installed in such residential structures due to existing water or soil conditions. Second, any building permit issued by the local building official authorizing the use of CPVC based on such a finding would be conditioned on compliance with specific mitigation measures described below. Third, only CPVC plumbing material listed as an approved material and installed in accordance with the California Plumbing Code could be used. Fourth, any installation and use of CPVC plumbing material pursuant to this local authorization would be required to comply with all applicable requirements of the California Plumbing Code and specific Installation Standards. Fifth, prior to issuing a building permit authorizing use of CPVC, the building official must require that any contractor or subcontractor provide written certification that such contractor or subcontractor: 1) is aware of the health and

safety hazards associated with CPVC plumbing installations, has included the hazards associated with CPVC in its Illness and Injury Prevention Plan, and has included worker safety training elements in its Injury Prevention Plan that meet the guidelines of the Department of Industrial Relations; and 2) will comply with the flushing procedures and worker safety measures required as a part of these regulations. Sixth, the building official would not be authorized to give final permit approval to the installation of any CPVC plumbing materials unless he or she finds that the material has been installed in compliance with the requirements of the California Plumbing Code and specified Installation Standards. Seventh, any contractor or subcontractor found to have failed to comply with the mitigation requirements imposed by these regulations would be subject to penalties set forth in Health and Safety Code sections 17955 et seq. Finally, if during the conduct of any building inspection the building official found that the worker safety requirements imposed by these regulations were being violated, the building official would be required to cite that contractor or subcontractor for such violation.

The regulatory proposal also incorporates the following specific mitigation measures that would be adopted in a new section 301.0 of Appendix I Installation Standards of the California Plumbing Code:

301.0.1 Flushing Procedures.

301.0.1.1 All installations of CPVC pipe within residential structures shall be flushed twice over a period of at least one week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. At the time of the fill, each fixture shall have a removable tag applied stating:

"This new plumbing system was first filled on (date) by (name). The California Department of Housing and Community Development requires that the system be flushed after standing at least one week after the fill date specified above. If the system is used earlier than one week after the fill date, the water must be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to flushing, except by the homeowner."

301.0.2 Worker Safety Measures.

301.0.2.1 Mechanical ventilation sufficient to maintain exposures below the relevant exposure limits established by state regulations shall be provided in enclosed spaces. This ventilation shall be directed at the breathing zone of the worker installing the pipe. Where mechanical ventilation is not practical, respirators, suitable for organic vapors, shall be used. For the purpose of this subdivision, and enclosed space is defined as:

(a) A space less than 100 square feet of floor area under a ceiling with a height of 10 feet or less, and which does not have openings (consisting of doors, windows, or unfinished walls) on at least two sides;
(b) Crawl spaces having a height of less than three feet;
(c) Enclosed attics that have a roof and ceiling; or
(e) Trenches having a depth greater than twenty-four inches.

3.01.0.2.2 Installers of CPVC pipe within residential structures shall use non-latex thin gauge (4 millimeters) nitrile gloves, or other gloves providing an equivalent or better degree of protection during the installation of the CPVC plumbing system. Gloves shall be provided to all workers by the contractor, or plumbing subcontractor, and shall be replaced upon contamination by cements.

This regulatory proposal and Negative Declaration are also being prepared pursuant to an agreement to settle a lawsuit challenging an Environmental Impact Report (EIR) that had been certified by HCD with regard to a previous HCD proposal to approve CPVC for statewide use. This settlement agreement provides for rescission of the prior EIR certification and withdrawal of the proposed regulations approving CPVC on a statewide basis. In addition to the conditions and mitigation measures described above, the settlement agreement provides that HCD will issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. The settlement agreement also provides for HCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Because the local CPVC approval authority that would be granted by the proposed regulations requires findings of existing or expected metallic pipe failure due to existing soil and water conditions, the potential scope of CPVC use that will result from the proposed project will be limited. Information in the record of previous HCD examinations of CPVC pipe indicates that corrosive drinking water is not a widespread

problem in California. The evidence before the Lead Agency indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. Finally, no cities or counties have filed with HCD modifications or changes in California Plumbing Code provisions to approve CPVC pipe pursuant to Health and Safety Code section 17958.7. For these reasons, the Lead Agency has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

Environmental Checklist Form

1. Project title: Regulations for the limited use of CPVC in Residential Buildings

2. Lead agency name and address:
Department of Housing and Community Development
1800 3rd Street
Sacramento, CA 95814

3. Contact person and phone number: Bill Staack (916) 323-7288

4. Project location: Statewide

5. Project sponsor's name and address:
N/A This project is a proposed action by a state agency.

6. General plan designation: N/A 7. Zoning: Residential

8. Description of project: (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)
Adoption of regulations (building standards) for the limited use of CPVC pipe in residential structures where it is determined by a local building official that there is or will be the premature failure of metallic pipe and the pipe is installed pursuant to specified mitigation measurer. SEE PAGE 1 OF PROJECT DESCRIPTION FOR DETAILED DESCRIPTION.

9. Surrounding land uses and setting: Briefly describe the project's surroundings:
This is a statewide project and is not site-specific. However, in general the surrounding land use and setting will be residential buildings where there may be a finding of premature failure of metallic pipe by the local building official.

10. Other public agencies whose approval is required (e.g., permits, financing approval, or participation agreement.)
The California Building Standards Commission

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology /Soils
☐ Hazards & Hazardous Materials	☐ Hydrology / Water Quality	☐ Land Use / Planning

☐ Mineral Resources ☐ Noise ☐ Population / Housing

☐ Public Services ☐ Recreation ☐ Transportation/Traffic

☐ Utilities / Service Systems ☐ Mandatory Findings of Significance

DETERMINATION: (To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

[X] I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature _____ Date _____

Julie Bornstein, Director
Printed name _____ For _____

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose

sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) Once the lead agency has determined that a particular physical impact may occur, then the checklist answers must indicate whether the impact is potentially significant, less than significant with mitigation, or less than significant. "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect may be significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.

4) "Negative Declaration: Less Than Significant With Mitigation Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less Than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case, a brief discussion should identify the following:

   a) Earlier Analysis Used. Identify and state where they are available for review.

   b) Impacts Adequately Addressed. Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.

   c) Mitigation Measures. For effects that are "Less than Significant with Mitigation Measures Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different formats; however, lead agencies should normally address the questions from this checklist that are relevant to a project's environmental effects in whatever format is selected.

9) The explanation of each issue should identify:
   a) the significance criteria or threshold, if any, used to evaluate each question; and
   b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

Issues:

	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	X
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	X
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	X
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	X
II. AGRICULTURE RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	X
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	X
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	X
III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				

a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	X	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	X	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	X	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	X
e) Create objectionable odors affecting a substantial number of people?	☐	☐	x	☐

IV. BIOLOGICAL RESOURCES -- Would the project:

a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☐	X
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☐	X
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☐	X
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☐	X

e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	X
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	X
<u>V. CULTURAL RESOURCES</u> -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	X
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☐	☐	X
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	X
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	X
<u>VI. GEOLOGY AND SOILS</u> -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:	☐	☐	☐	X
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	X
ii) Strong seismic ground shaking?	☐	☐	☐	X
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	X
iv) Landslides?	☐	☐	☐	X
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	X
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☐	☐	☐	X
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	X

e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	X

VII. HAZARDS AND HAZARDOUS MATERIALS --

Would the project:

a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	X
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	X	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	X	☐
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	X
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	X
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	X
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	X

VIII. HYDROLOGY AND WATER QUALITY -- Would the project:

a) Violate any water quality standards or waste discharge requirements?	☐	X	☐	☐

b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				X
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?				X
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?				X
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?				X
f) Otherwise substantially degrade water quality?		X		
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?				X
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				X
j) Inundation by seiche, tsunami, or mudflow?				X
<u>IX. LAND USE AND PLANNING</u> - Would the project:				
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				X
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				X

X. MINERAL RESOURCES -- Would the project:

a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	X
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	X

XI. NOISE --

Would the project result in:

a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	X
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☐	X
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	X
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	X
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	X
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	X

XII. POPULATION AND HOUSING -- Would the project:

a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	X

XIII. PUBLIC SERVICES

a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				X
Fire protection?				X
Police protection?				X
Schools?				X
Parks?				X
Other public facilities?				X

XIV. RECREATION --

a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				X

XV. TRANSPORTATION/TRAFFIC -- Would the project:

a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?				X
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				X
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				X
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				X
e) Result in inadequate emergency access?				X
f) Result in inadequate parking capacity?				X

g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	X

XVI. UTILITIES AND SERVICE SYSTEMS --

Would the project:

a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	X
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	X
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	X
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	X
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	X
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	X

Explanation of Checklist Judgments

The following are brief explanations of all answers in the Environmental Checklist Form for the proposed project, which, as described above under Project Description, consists of an amendment to the California Plumbing Code authorizing local building officials to approve use of CPVC pipe as an alternate building material under limited circumstances and subject to specified conditions and mitigation measures. For the majority of the "No Impact" responses to the Environmental Checklist, the Lead Agency has determined that the potential effects are not applicable to this project. For the balance of the "No Impact" responses the Lead agency has determined that due to the limited scope of the project and/or mitigation measures that have been incorporated into the proposed project, environmental effects will result in "No Impact." For the remainder of the responses, the Lead Agency has determined that the proposed project will result in less than significant impacts.

The determinations made for this Environmental Checklist are based on the information in the record for this project as well as information in the record of previous HCD examinations of CPVC for use in residential buildings. The determinations made for this Environmental Checklist are based on the limited scope of the proposed Project and/or the specific worker safety requirements, flushing requirements, and other conditions and mitigation measures incorporated as part of the local permit approval process, a requirement contained in the settlement agreement that the Lead Agency inform local building officials of the specific mitigation measures required for CPVC approvals, and the on-going, periodic monitoring of the implementation of such mitigation measures by the Lead Agency.

I. AESTHETICS.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in

XVII. MANDATORY FINDINGS OF SIGNIFICANCE --	Potentially Significant Impact	Less than Significant With Mitigation	Less Than Significant Impact	No Impact
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	X
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	X	X	☐
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	X	☐	☐

residential buildings and will not result in impacts to scenic vistas.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in damage to scenic vistas.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not degrade existing visual character or qualities of any site or it's surroundings.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in light or glare that would affect day or nighttime views.

II. AGRICULTURE RESOURCES.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in the conversion of any farmland.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in any conflict with existing agricultural use zoning or a Williamson Act contract.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in environmental changes causing conversion of Farmland to non-agricultural use.

III. AIR QUALITY.

a. **Less than Significant:** CPVC pipe and fittings are joined using primers and cements that contain volatile organic compounds ("VOC"), principally tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The primers and cements used for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. The VOCs from the primers and cements are considered ozone precursors, and form ozone through complex photochemical reactions in the atmosphere with oxides of nitrogen ("NOx"). California and federal air quality regulations limit ozone concentrations in the atmosphere. The proposed Project would authorize local building officials to permit the use of CPVC water supply pipe in residential building upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. As discussed above under Project Description, the Lead Agency anticipates that the CPVC installations that will result from this Project approval would be limited in scope because it will only be used in those jurisdictions where the local building official determines that there is or will be the premature failure of metallic pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC pipe for use in residential buildings, the Lead Agency has determined that this project will be consistent with the local Air Quality Management Plans for primers and cements used in the installation of plastic pipe and there will be no conflict with or obstruction in the implementation of any local air quality plan. This determination is based on the limited number of anticipated residential installations of CPVC that may be approved as a result of the proposed Project, the temporary nature of the VOC emissions and the VOC emission levels estimated in the analyses contained in the record before the Lead Agency.

b. **Less than Significant:** CPVC pipe and fittings are joined using primers and cements that contain volatile organic compounds ("VOC"), principally tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The primers and cements used for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. The VOCs from the primers and cements are considered ozone precursors, and form ozone through complex photochemical reactions in the atmosphere with oxides of nitrogen ("NOx"). California and federal air quality regulations limit ozone concentrations in the atmosphere. The proposed Project would authorize local building officials to permit the use of CPVC water supply pipe in residential building upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. As discussed above under Project Description, the Lead Agency anticipates that the CPVC installations that will result from this Project approval would be limited in scope because it will only be used in those jurisdictions where the local building official determines that there is or will be the premature failure of metallic pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC pipe for use in residential buildings, the Lead Agency has determined that this project will be consistent with the local Air Quality Management Plans for primers and cements used in the installation of plastic pipe and will not result in any air quality standard violation for ozone or contribute substantially to an existing or projected air quality standard for ozone. This determination is based on the limited number of anticipated residential installations of CPVC that may be approved as a result of the proposed Project, the temporary nature of the VOC emissions and the VOC emission levels estimated in the analyses contained in the record before the Lead Agency.

c. **Less than Significant:** CPVC pipe and fittings are joined using primers and cements that contain volatile organic compounds ("VOC"), principally tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The primers and cements used for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. The VOCs from the primers and cements are considered ozone precursors, and form ozone through complex photochemical reactions in the atmosphere with oxides of nitrogen ("NOx"). California and federal air quality regulations limit ozone concentrations in the atmosphere. The proposed Project would authorize local building officials to permit the use of CPVC water supply pipe in residential building upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. As discussed above under Project Description, the Lead Agency anticipates that the CPVC installations that will result from this Project approval would be limited in scope because it will only be used in those jurisdictions where the local building official determines that there is or will be the premature failure of metallic pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC pipe for use in residential buildings, the Lead Agency has determined that this project will be consistent with the local Air Quality Management Plans for primers and cements used in the installation of plastic pipe and will not result in a cumulatively considerable net increase of any criteria pollutant for which a project region may be nonattainment under an applicable federal or state ambient air quality standard. This determination is based on the limited number of anticipated residential installations of CPVC that may be approved as a result of the proposed Project, the temporary nature of the VOC emissions and the VOC emission levels estimated in the analyses contained in the record before the Lead Agency.

d. **No impact:** CPVC pipe and fittings are joined using primers and cements that contain volatile organic compounds ("VOC"), principally tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The primers and cements used for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. The proposed Project would authorize local building officials to permit the use of CPVC water supply pipe in residential buildings upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. As discussed above under Project Description, the Lead Agency anticipates that the CPVC installations that will result from this Project approval would be limited in scope because it will only be used in those jurisdictions where the local building official determines that there is or will be the premature failure of metallic pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC pipe for use in residential buildings, the Lead Agency has determined that this project will be consistent with the local Air Quality Management Plans for primers and cements used in the installation of plastic pipe and will not result in exposure of sensitive receptors to substantial pollutant concentrations. This determination is based on the limited number of anticipated residential installations of CPVC that may be approved as a result of the proposed Project, the temporary nature of the VOC emissions and the VOC emission levels estimated in the analyses contained in the record before the Lead Agency.

e. **Less than significant impact:** CPVC pipe and fittings are joined using primers and cements that contain volatile organic compounds ("VOC"), principally tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The primers and cements used for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. The proposed Project would authorize local building

officials to permit the use of CPVC water supply pipe in residential building upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. As discussed above under Project Description, the Lead Agency anticipates that the CPVC installations that will result from this Project approval would be limited in scope because it will only be used in those jurisdictions where the local building official determines that there is or will be the premature failure of metallic pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC pipe for use in residential buildings, the Lead Agency has determined that this project will be consistent with the local Air Quality Management Plans for primers and cements used in the installation of plastic pipe and will not create objectionable odors affecting a substantial number of people. This determination is based on the limited number of anticipated residential installations of CPVC that may be approved as a result of the proposed Project, the temporary nature of the VOC emissions and the VOC emission levels estimated in the analyses contained in the record before the Lead Agency.

IV. BIOLOGICAL RESOURCES.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in impacts to any endangered, threatened, or rare species or their habitats identified in any local or regional plans, policies, or regulations, or by the California Department of Fish and Game or the U.S. Fish and Wildlife Service.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in

impacts on any riparian habitat or other sensitive natural community identified in any local or regional plans, policies, or regulations, or by the California Department of Fish and Game or the U.S. Fish and Wildlife Service.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in impacts on federally protected wetlands as defined by Section 404 of the Clean Water Act.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in impacts on wildlife dispersal or migration corridors or impede the use of native wildlife nursery sites.

e. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in conflicts with any local policies or ordinances protecting biological resources.

f. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in conflicts with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other local, regional, or state habitat conservation plan.

V. CULTURAL RESOURCES.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not impact historical resources.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not disturb archaeological resources.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in disturbance of paleontological resources or unique geologic features.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in disturbances on any human remains.

VI. GEOLOGY AND SOILS.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exposing people or structures to any effects including the risk of loss, injury, or death involving:

   i. Rupture of a known earthquake faults.
   ii. Strong seismic ground shaking.
   iii. Seismic-related ground failure, including liquefaction.
   iv. Landslides.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in any erosion or loss of topsoil.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in, or

expose people to unstable soil or geologic conditions.

d. **No impact**: This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in, or expose people to expansive soils.

e. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in, or expose people to soil conditions incapable of supporting any structures.

VII HAZARDS AND HAZARDOUS MATERIALS

a. **No impact:** The proposed Project would authorize local building officials to approve installation and use of CPVC water supply pipe in residential structures under limited circumstances and subject to specified conditions and mitigation measures, including the measures designed to educate those persons most likely to be handling, transporting, installing, and disposing of CPVC plumbing materials about the health and safety hazards associated with CPVC plumbing materials and installations. CPVC pipe and fittings are joined during installation using primers and cements that contain certain solvent chemicals, including tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The use of the primers and cements for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. The primers and cements are routinely transported and used at the installation site and any waste being generated is disposed pursuant to local regulations. The water carried by CPVC pipe can contain trace contaminants from the CPVC plastic itself, as well as solvent chemical leachate from the primers and cements used to join the pipe and fittings. Drinking water consumers would be exposed to any contaminants leaching into the

drinking water carried by the pipe. In addition, workers would be exposed to the solvent chemicals contained in the CPVC primers and cements through inhalation and dermalabsorption during the installation process. As discussed under Project Description, the proposed Project incorporates a specific set of detailed consumer and worker safety mitigation measures that have been developed to minimize chemical exposure to the installers and to the drinking water of the consumers. In addition, upon adoption of the proposed regulations, the Lead Agency will send information to the local building officials informing them of the specific mitigation measures required for any local approval of CPVC use. The Lead Agency will also periodically monitor the local implementation of the required consumer and worker safety mitigation measures. Based on the information in the record for this project as well as information in the record of previous HCD examinations of CPVC for use in residential buildings, the Lead Agency has determined that any uses of CPVC that would be authorized as a result of the proposed project will not create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials.

b. **Less Than Significant:** The proposed Project would authorize local building officials to approve installation and use of CPVC water supply pipe in residential structures under limited circumstances and subject to specified conditions and mitigation measures. CPVC pipe and fittings are joined during installation using primers and cements that contain certain solvent chemicals, including tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The use of the primers and cements for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC for use in residential buildings, the Lead Agency has determined that any uses of CPVC that would be authorized as a

result of the proposed project will result in less than significant risk of a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment.

c. **Less Than Significant:** The proposed Project would authorize local building officials to approve installation and use of CPVC water supply pipe in residential structures under limited circumstances and subject to specified conditions and mitigation measures. CPVC pipe and fittings are joined during installation using primers and cements that contain certain solvent chemicals, including tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The use of the primers and cements for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC for use in residential buildings, the Lead Agency has determined that any uses of CPVC that would be authorized as a result of the proposed project will result in less than significant impacts on emissions of hazardous emissions or handling of hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not impact a site, which is included on a list of hazardous materials sites nor result a hazard to the public or the environment.

e. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in a safety hazard for people residing or working within an airport land use plan or within two miles of a public airport or public use airport.

f. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in a safety hazard for people residing or working within the vicinity of a private airstrip.

g. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not interfere with an emergency response plan or emergency evacuation plan.

h. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not expose people or structures to a risk of loss, injury or death involving wildland fires.

VIII. HYDROLOGY AND WATER QUALITY.

a. **Less Than Significant With Mitigation Incorporation:** The proposed Project would authorize local building officials to approve installation and use of CPVC water supply pipe in residential structures under limited circumstances and subject to specified conditions and mitigation measures. The use of the primers and cements for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. CPVC pipe is manufactured from CPVC resins using heat and pressure. CPVC used for potable water pipe and fittings has certain stabilizers added to protect it from degradation during forming and use. The CPVC manufacturing formulas currently employed use tin-containing organic compounds as stabilizers. CPVC also contains other additives, including pigments and lubricants to facilitate forming of the pipe and fittings. In addition, CPVC pipe and fittings are joined during installation using primers and cements that contain certain solvent chemicals,

including tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The water carried by CPVC pipe can contain trace contaminants from the CPVC plastic itself, as well as solvent chemical leachate from the primers and cements used to join the pipe and fittings. Drinking water consumers would be exposed to any contaminants leaching into the drinking water carried by the pipe. As discussed under Project Description, the proposed project incorporates a specific mitigation measure to flush the water distribution system of any contaminants prior to the domestic use. In addition, upon adoption of the proposed regulations, the Lead Agency will send information to the local building officials informing them of the specific mitigation measures required for any local approval of CPVC use. The Lead Agency will also periodically monitor the local implementation of the required flushing requirements. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC for use in residential buildings, the Lead Agency has determined that any uses of CPVC that would be authorized as a result of the proposed project would not violate any water quality standards or waste discharge requirements.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in changes in the amount of groundwater supplies.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in changes in any existing drainage patterns resulting in erosion or siltation on-site or off-site.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in

changes in any existing drainage patterns resulting in flooding on-site or off-site.

e. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in any existing or planned stormwater drainage system.

f. **Less Than Significant With Mitigation Incorporation:** The proposed Project would authorize local building officials to approve installation and use of CPVC water supply pipe in residential structures under limited circumstances and subject to specified conditions and mitigation measures. The use of the primers and cements for the installation of plastic pipe are currently allowed in California for PVC, non-residential use of CPVC and ABS pipe. CPVC pipe is manufactured from CPVC resins using heat and pressure. CPVC used for potable water pipe and fittings has certain stabilizers added to protect it from degradation during forming and use. The CPVC manufacturing formulas currently employed use tin-containing organic compounds as stabilizers. CPVC also contains other additives, including pigments and lubricants to facilitate forming of the pipe and fittings. In addition, CPVC pipe and fittings are joined during installation using primers and cements that contain certain solvent chemicals, including tetrahydrofuran, methyl ethyl ketone, and cyclohexanone. The water carried by CPVC pipe can contain trace contaminants from the CPVC plastic itself, as well as solvent chemical leachate from the primers and cements used to join the pipe and fittings. Drinking water consumers would be exposed to any contaminants leaching into the drinking water carried by the pipe. As discussed under Project Description, the proposed project incorporates a specific mitigation measure to flush the water distribution system of any contaminants prior to the domestic use. In addition, upon adoption of the proposed regulations, the Lead Agency will send information to the local building officials informing them of the specific mitigation

measures required for any local approval of CPVC use. The Lead Agency will also periodically monitor the local implementation of the required flushing requirements. Based on the information in the record of this project as well as information in the record of previous HCD examinations of CPVC for use in residential buildings, the Lead Agency has determined that any uses of CPVC that would be authorized as a result of the proposed project would not otherwise substantially degrade water quality.

g. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in placing housing within a 100-year flood hazard area.

h. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in placing structures within a 100-year flood hazard area.

i. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exposing people or structures involving flooding.

j. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in inundation by seiche, tsunami, or mudflows.

IX. LAND USE AND PLANNING.

a. **No Impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not disrupt or

divide the physical arrangement of an existing community.

b. **No Impact**: This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not have conflicts with any applicable land use plan, policy, or regulation.

c. **No Impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not conflict with any applicable habitat conservation plan or natural community conservation plan.

X. MINERAL RESOURCES.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in the loss of availability of a known mineral resource that would be of future value to the residents of the State.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in loss of availability of a locally-important mineral resources recovery site delineated on a local general plan, specific plan, or other land use plan.

XI NOISE.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exposure of people to severe noise levels.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exposure of people to excessive groundborne vibration or groundborne noise levels.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in an increase in ambient noise levels above existing levels.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in temporary or periodic increase in ambient noise levels above existing levels.

e. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exposure of people to excessive noise levels within an airport land use plan or within two miles of a public airport or public use airport.

f. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exposure of people to excessive noise within the vicinity of a private airstrip.

XII. POPULATION AND HOUSING.

a. **No Impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not induce population growth.

b. **No Impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not displace any existing housing.

c. **No Impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not displace any people.

XIII. PUBLIC SERVICES.

a. **No impact**: This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in physical impacts associated with the provisions of new or physically altered governmental facilities for any of the following public services:

- Fire Protection
- Police Protection
- Schools
- Parks
- Other public facilities.

XIV. RECREATION.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in any increased use of existing neighborhood or regional parks or other recreational facilities.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and does not include recreational facilities.

XV. TRANSPORTATION AND CIRCULATION.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in increased vehicle trips or traffic congestion.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in causing the level of service standard established by the local government to be exceeded.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in changes to air traffic patterns.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in increasing road hazards.

e. **No impact**: This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in inadequate emergency access.

f. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in inadequate parking capacity.

g. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in conflict with adopted policies, plans, or programs supporting alternative transportation.

XVI. UTILITIES AND SERVICE SYSTEMS.

a. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in exceeding wastewater treatment requirements of the applicable Regional Water Quality Control Board.

b. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in a need for new construction or expansion of existing water and wastewater treatment facilities.

c. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in a need for new construction or expansion of existing storm water drainage facilities.

d. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not result in impact on existing water supply entitlements and resources.

e. **No impact:** This issue is not applicable to the proposed Project. The proposed Project relates to the use of an alternate building material in residential buildings and will not impact wastewater treatment providers.

f. **No impact:** The proposed Project would authorize local building officials to authorize use of CPVC water supply pipe upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. As discussed above under Project Description, the Lead Agency anticipates that the number of CPVC installations that will

result from this Project approval will be limited. Based on the information in the record of this proceeding and previous HCD examinations of CPVC pipe for residential installations of CPVC and the widely scattered distribution expected for those uses, there will be sufficient landfill capacity to accommodate the project's solid waste disposal needs.

g. **No impact:** The proposed Project would authorize local building officials to authorize use of CPVC water supply pipe upon a finding that metallic pipe has failed or would fail if installed due to existing soil or water conditions. In addition, CPVC water supply pipe is already approved for non-residential use in California. Therefore, approval of the Project will not introduce any new or different materials into the solid waste stream or require new or different solid waste disposal practices. Finally, as discussed above under Project Description, the Lead Agency anticipates that the number of CPVC installations that will result from this Project approval will be limited. Therefore, the Lead Agency had determined that the increase in the amount of CPVC in the solid waste stream will be less than significant. Based on the information in the record of this proceeding and previous HCD examinations of CPVC pipe for residential use, the Lead Agency has determined that the project will comply with federal, state and local statutes and regulations related to solid waste.

XVII. MANDATORY FINDINGS OF SIGNIFICANCE.

a. **No impact:** This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not have the potential to degrade quality of the environment, substantially reduce the habitat of a fish or wildlife species cause a fish or wildfire population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or eliminate

important examples of major periods of California history or prehistory.

b. **Less than significant impact with and without mitigation measures:** The Lead Agency has determined that the impacts on air quality created by the project's potential for contributing to photochemical smog are less than significant and not cumulatively considerable. The Lead Agency has further determined that the impacts on worker health and safety relating to the nature of the materials and processes used to install CPVC, and the impacts on water quality created by the project's potential for producing leachates into consumer drinking water are less than significant if mitigation measures identified in the proposed project are required. (See above, III(a) and (b), and VIII(a) and (f).)

c. **Less than significant impact with mitigation measures:** The Lead Agency has determined that the impacts on worker health and safety relating to the nature of the materials and processes used to create and install CPVC, and the impacts on water quality created by the Project's potential for producing leachates into consumer drinking water are less than significant if the specified mitigations measures are required.

2

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American National Standard
for Drinking Water Additives —

Drinking water system components — Health effects

Standard Developer

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Contents

Foreword ix

Consortium organizations xi

1 Purpose, scope, and normative references 1
1.1 Purpose 1
1.2 Scope 1
1.3 Normative references 1
1.4 Limitations 2
1.5 Alternate products or materials 3

2 Definitions 3

3 General requirements 4
3.1 General 4
3.2 Information and formulation requirements 4
3.3 Identification of analytes 5
3.4 Products manufactured from annex C acceptable materials 6
Table 3.1 – Material-specific analyses 7

4 Pipes and related products 9
4.1 Scope 9
4.2 Definitions 9
4.3 General requirements 9
4.4 Sample requirements 10
4.5 Extraction procedures 10
4.6 Analysis 15
4.7 Normalization of contaminant concentrations 15
4.8 Evaluation of contaminant concentrations 16
Table 4.1 – Example single time point conditioning schedule 17
Table 4.2 – Single time point exposure schedule 17
Table 4.3 – Example multiple time point conditioning/exposure schedule 18
Table 4.4 – Pipes – normalization factors and assumptions 19
Table 4.5 – Fittings (installed at regular intervals) – normalization factors and assumptions 20
Table 4.6 – Example normalization calculations 21

5 Barrier materials 22
5.1 Scope 22
5.2 Definitions 22
5.3 General requirements 23
5.4 Sample requirements 23
5.5 Extraction procedures 24
5.6 Analysis of extraction water 27
5.7 Normalization 27
5.8 Evaluation of contaminant concentrations 28
Table 5.1 – Paint and coating system sample preparation 29
Table 5.2 – Single time point exposure sequence 29
Table 5.3 – Multiple time point exposure sequence 29
Table 5.4 – Surface area-to-volume ratios for tanks or storage vessels 30

6 Joining and sealing materials 31
6.1 Coverage 31
6.2 Definitions 31
6.3 Material and extraction testing requirements 31

6.4 Items of special significance .. 31

7 Process media 31
7.1 Scope 31
7.2 Definitions 31
7.3 General requirements 32
7.4 Sample requirements 32
7.5 Extraction procedures 33
7.6 Analysis 35
7.7 Normalization 35
7.8 Evaluation of contaminant concentrations 36
Table 7.1 – Product-specific minimum test batteries for process media products 37
Table 7.2 – Process media exposure weight-per-volume ratios 37
Table 7.3 – Maximum conditioning expansion rates for filtration and adsorption media 38
Table 7.4 – Exposure schedule for process media of ≥ 0.25 mm in diameter 38

8 Mechanical devices 38
8.1 Coverage 38
8.2 Definitions 38
8.3 Device, component, or material requirements 38
8.4 In-line devices, components, and materials 39
8.5 Chemical feeders and generators 39
8.6 Other mechanical devices, components, and materials 39
Table 8.1 – Examples of mechanical devices 40

9 Mechanical plumbing devices 40
9.1 Coverage 40
9.2 Definitions 42
9.3 Device, component, or material requirements 42
9.4 Exposure and normalization 43
9.5 Evaluation of normalized contaminant concentrations 43

Annexes

A Toxicology review and evaluation procedures A1
A.1 General requirements A1
A.2 Definitions A1
A.3 Data requirements for published risk assessments A4
A.4 Data requirements for new or updated risk assessments A5
A.5 Data requirements for evaluating short-term exposures A6
A.6 Risk estimation for published assessments A7
A.7 Risk estimation using new and updated risk assessments A7
A.8 Risk estimation for short-term exposure (STEL calculation) A14
A.9 Development of chemical class-based evaluation criteria A14
A.10 Key elements of a risk assessment for drinking water additive chemicals A16
References A20
Table A1 – Qualitative risk assessment data requirements A24
Table A2 – Quantitative risk assessment data requirements A25
Table A3 – TACs for qualitative risk assessment A26
Table A4 – Uncertainty factors A26

B Product/material evaluation B1
B.1 Background B1
B.2 General evaluation requirements B1
B.3 Joining and sealing materials B4
B.4 Mechanical devices B6
B.5 Mechanical plumbing devices B8
B.6 Collection and preservation of extraction media following exposure B10
B.7 Analysis methods B10
B.8 Normalization B17
B.9 Extraction water preparation B22
Figure B1 – Exposure sequence for mechanical plumbing device B25
Table B1 – NSF/ANSI 61 products B26
Table B2 – Exposure summary B26
Table B3 – Extraction water selection B27
Table B4 – Test samples joining and sealing materials B27
Table B5 – Exposure sequence for cold applications B27
Table B6 – Exposure sequence for hot applications B28
Table B7 – Product exposure1 ..... B28
Table B8 – In-line device exposure sequence B28
Table B9 – Other mechanical device exposure sequence B29
Table B10 – Extractant water collection and preservation B29
Table B11 – Normalization factors, assumptions, and examples pertaining to B30
Table B12 – Data available for determination of lead test statistic B36
Table B13 – Values of k1 for determining test statistic Q B36
Table B14 – Values of k2 for determining retest statistic R B36
Table B15 – One-liter volume of extraction water B37

C Acceptable materials C1
C.1 Purpose C1
C.2 Evaluation of acceptable materials C1
C.3 Extraction testing C1
C.4 Documentation C1
Table C1 – Acceptable materials C2

D Normative drinking water criteria D1
D.1 General D1
D.2 USEPA and Health Canada drinking water criteria D1
D.3 NSF International peer-reviewed drinking water criteria D1
D.4 Drinking water criteria based on USEPA guidance concentrations D2
D.5 Threshold of evaluation (TOE) chemical list D2
Table D1 – U.S. Environmental Protection Agency and Health Canada D3
Table D2 – NSF International peer-reviewed drinking water criteria D9
Table D3 – Drinking water criteria based on USEPA guidance concentrations D12
Table D4 – Threshold of evaluation chemicals1 ..... D24

E Informational drinking water criteria E1
E.1 General E1
E.2 NSF International drinking water criteria (not externally peer-reviewed) E1
E.3 Informational threshold of evaluation chemicals E2
Table E1 – NSF International drinking water criteria (not externally peer reviewed) E3
Table E2 – Threshold of evaluation chemicals having datasets from which specific TAC/SPAC values, or CBEL values, could be set using Annex A1 ..... E6

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Foreword[2]

In response to a competitive request for proposals from the U.S. Environmental Protection Agency (USEPA), a Consortium led by NSF International (NSF) agreed to develop voluntary third-party consensus standards and a certification program for all direct and indirect drinking water additives. Other members of the Consortium include the American Water Works Association Research Foundation, the Association of State Drinking Water Administrators, the Conference of State Health and Environmental Managers, and the American Water Works Association. (COSHEM has since become inactive as an organization.) Each organization was represented on a steering committee with oversight responsibility for the administration of the cooperative agreement. The Steering Committee provides guidance on overall administration and management of the cooperative agreement. Currently, the member organizations remain active in an oversight role

Two standards for additives products were developed. NSF/ANSI 60 – *Drinking water treatment chemicals — Health effects* covers many of the water treatment chemicals, also known as direct additives. This Standard, NSF/ANSI 61 – *Drinking water system components — Health effects*, covers all indirect additives products and materials. Testing to determine the potential of a product to impart taste and/or odor to drinking water is not included in this Standard

NSF/ANSI 61 was developed to establish minimum requirements for the control of potential adverse human health effects from products that contact drinking water. It does not attempt to include product performance requirements that are currently addressed in other voluntary consensus standards established by such organizations as the American Water Works Association, the American Society for Testing and Materials, and the American National Standards Institute. Because this Standard complements the performance standards of these organizations, it is recommended that products also meet the appropriate performance requirements specified in the standards of such organizations.

NSF/ANSI 61, and subsequent product certification against it, has replaced the USEPA Additives Advisory Program for drinking water system components. USEPA terminated its advisory role in April 1990. For more information with regard to USEPA's actions, refer to the July 7, 1988 *Federal Register* (53FR25586).

This Standard and the accompanying text are intended for voluntary use by certifying organizations, utilities, regulatory agencies, and/or manufacturers as a basis of providing assurances that adequate health protection exists for covered products Product certification issues, including frequency of testing and requirements for follow-up testing, evaluation, enforcement, and other policy issues, are not addressed by this Standard.

Water contact materials in Drinking Water Treatment Units listed under NSF/ANSI 42, 44, 53, 55, 58, and 62 are tested and evaluated under a separate protocol from NSF/ANSI 61 with criteria which were developed specifically for the intended end-use. NSF 61 listing should not be additionally required for acceptance of these listed units for water contact application.

This version of the Standard includes the following revisions:

- Changes have been made to Table 4.4 of the Standard to provide consistency with Sections 4.7.1 and 4.8.1 to reflect actual field conditions for Copper products with 4" nominal O.D.'s and greater

- Recent additions of Organics/Pesticides considered contaminants by the U.S. Environmental Protection Agency and Health Canada have been added to Annex D and Annex E.

[2] The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

- Several tables in Annex D and Annex E have been restructured, reformatted, and entries relocated to provide reader clarity.

- Table D1 includes the new effective date of the potential lowering of the bromate SPAC.

This Standard was developed by the NSF Joint Committee on Drinking Water Additives using the consensus process described by the American National Standards Institute

Suggestions for improvement of this Standard are welcome. Comments should be sent to Chair, Joint Committee on Drinking Water Additives, c/o NSF International, Standards Department, PO Box 130140, Ann Arbor, Michigan 48113-0140, USA.

Consortium organizations[3]

NSF International

Popularly referred to as NSF, NSF International is a noncommercial agency. It is incorporated under the laws of Michigan as a not-for-profit organization devoted to research, education, and service. It seeks to solve problems involving man and his environment. It wishes to promote health and enrich the quality of life through conserving and improving that environment. Its fundamental principle of operation is to serve as a neutral medium in which business and industry, official regulatory agencies, and the public come together to deal with problems involving products, equipment, procedures, and services related to health and the environment It is conceived and administered as a public service organization.

NSF is perhaps best known for its role in developing standards and criteria for equipment, products, and services that bear upon health NSF was the lead organization in the Consortium responsible for developing this Standard NSF conducts research, tests and evaluates equipment, products, and services for compliance with standards and criteria; and grants and controls the use of NSF registered Marks.

NSF offers product certification (Listing Services) for all products covered by its standards. Each program has established policies governing the associated product evaluation, Listing Services, follow-up and enforcement activities The NSF Listing Mark is widely recognized as a sign that the product or service to which it relates complies with the applicable NSF standard(s).

AWWA Research Foundation

The mission of the American Water Works Association Research Foundation (AWWARF) is to sponsor practical, applied research in behalf of the drinking water industry of North America. The scope of the research program embraces all aspects of water supply operation, from development and maintenance of water resources to treatment technologies and water quality issues, from storage and distribution system operations to health effects studies and utility planning and management activities. AWWARF serves as the centralized industry institution for planning, managing, and funding cooperative research and development in drinking water, including the subsequent transfer of technology and results for practical application by the water utility community.

AWWARF's purpose in this cooperative program is to provide a communication link with the water utilities throughout North America and serve as the focal point for identification of research needs of the water supply industry with respect to the additives program.

The Association of State Drinking Water Administrators

The Association of State Drinking Water Administrators (ASDWA) is a nonprofit organization whose eligible membership is comprised of drinking water program administrators in each of the 50 states and seven U.S. territories. Through the organization, representatives speak with a collective voice to Congressional committees, the United States Environmental Protection Agency (EPA), professional and trade associations, water utilities, and the general public on issues related to state drinking water programs. With its mission of protecting the public health through assurance of high quality drinking water, and promoting responsible, reasonable, and feasible drinking water programs at the state and federal levels, the Association is a valued contributor to the consortium, and to the program. It provides the link between the additives program and the state drinking water programs.

[3] The information contained in this section is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this section may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

The Conference of State Health and Environmental Managers

The Conference of State Health and Environmental Managers (COSHEM), known formerly as the Conference of State Sanitary Engineers (CSSE), is currently inactive as an organization. It brought to the consortium expertise and involvement of state health and environmental program managers. The Conference was the focal point for health concerns of all state environmental programs, including drinking water, wastewater, air, solid and hazardous wastes, radiological, occupational, health, and food. A standing committee on water supply focused on drinking water issues and kept the membership informed. The Conference played an important role early in the program through two-way communication with state health and environmental program decision makers.

American Water Works Association

The purpose of the American Water Works Association (AWWA) is to promote public health, safety, and welfare by improving the quality and increasing the quantity of water delivered to the public, and to developing and furthering an understanding of the problems relating thereto by:

- advancing the knowledge of the design, construction, operation, water treatment and management of water utilities;

- developing standards for procedures, equipment, and materials used by public water supply systems;

- advancing the knowledge of problems involved in the development of resources, production, and distribution of safe and adequate water supplies;

- educating the public on the problems of water supply and promoting a spirit of cooperation between consumers and suppliers in solving these problems; and

- conducting research to determine the causes of problems of providing a safe and adequate water supply and proposing solutions thereto in an effort to improve the quality and quantity of the water supply provided to the public.

AWWA brings to the Consortium its established position as the largest public drinking water association in North America, with a broad membership that includes utilities, consultants, manufacturers/distributors/agents, contractors, and other organizations with a direct interest in drinking water.

NSF/ANSI Standard
for Drinking Water Additives —

Drinking water system components – Health effects

1 Purpose, scope, and normative references

1.1 Purpose

This Standard establishes minimum health effects requirements for the chemical contaminants and impurities that are indirectly imparted to drinking water from products, components, and materials used in drinking water systems. This Standard does not establish performance, taste and odor, or microbial growth support requirements for drinking water system products, components, or materials.

1.2 Scope

1.2.1 This Standard is intended to cover specific materials or products that come into contact with: drinking water, drinking water treatment chemicals, or both. The focus of the Standard is evaluation of contaminants or impurities imparted indirectly to drinking water. The products and materials covered include, but are not limited to, process media (carbon, sand, etc.), protective materials (coatings, linings, liners, etc.), joining and sealing materials (solvent cements, welding materials, gaskets, etc.), pipes and related products (pipes, tanks, fittings, etc.), mechanical devices used in treatment/transmission/distribution systems (valves, chlorinators, separation membranes, etc.), and mechanical plumbing devices (faucets, endpoint control valves, etc.).

1.2.2 Point-of-use and point-of-entry drinking water treatment devices are not covered by the scope of this Standard.

1.2.3 Fire hydrants are not covered by the scope of this Standard.

1.3 Normative references

The following documents contain requirements, which by reference in this text, constitute requirements of this Standard.

APHA, *Standard Methods for the Examination of Water and Wastewater*, twentieth edition[4]

ASTM C31/C31M-00e1 *Standard Practice for Making and Curing Concrete Test Specimens in the Field*[5]

ASTM C109/C109M-99 *Standard Test Method for Compressive Strength of Hydraulic Cement Mortars*[5]

ASTM C192/C192M-00 *Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory*[5]

[4] American Public Health Association (APHA), 800 I Street, NW, Washington, DC 20001

[5] ASTM, Inc , 100 Barr Harbor Drive, West Conshohocken, PA 19428-2859

ASTM C511-98. *Standard Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes*[5]

ASTM C778-00. *Standard Specification for Standard Sand*[5]

ASTM D2855-96. *Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings*[5]

ASTM D3182-89 (1994). *Standard Practice for Rubber - Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets*[5]

ASTM F493-97. *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings*[5]

ANSI/AWWA B100-96 *AWWA Standard for Filtering Material*[6]

ANSI/AWWA C652-92 *AWWA Standard for Disinfection of Water-Storage Facilities*[6]

NSF/ANSI 60 – 2003. *Drinking water treatment chemicals - Health effects*

OECD, *OECD Guidelines for the Testing of Chemicals*, May 1996[7]

USEPA-600/4-79-020. *Methods for the Chemical Analysis of Water and Wastes*, March 1983[8]

USEPA-600/4-80-032. *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*[8]

USEPA, *Health Effects Testing Guidelines*, 40 CFR Part 798[9]

USEPA, *Good Laboratory Practice Standards*, 40 CFR Part 160[9]

USFDA, *Good Laboratory Practice for Non-Clinical Laboratory Studies*, 21 CFR 58[10]

USFDA, *Toxicological Principles for the Safety Assessment of Direct Food Additives and Color Additives in Food*[10]

1.4 Limitations

The requirements of this Standard are limited to addressing potential health effects, except where specific application and performance standards are referenced. This Standard does not establish taste and odor requirements for drinking water system products and materials. The criteria set forth in this Standard cover products produced by good manufacturing practices and generally recognized manufacturing processes. As the presence of unusual or unexpected impurities is frequently dependent upon the method of manufacture and the quality of raw material used, products prepared by other than recognized methods of manufacture or with unusual raw materials shall be fully evaluated in accordance with 3 of this Standard (general requirements). Products that have been evaluated and found to meet other NSF standards having health

[6] American Water Works Association (AWWA), 6666 Quincy Avenue, Denver, CO 80235-9913

[7] Organization for Economic Cooperation and Development (OECD), 2 Rue Andre-Pascal, 75775 Paris Cedex 16, France

[8] USEPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268

[9] Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

[10] USFDA, 5600 Fishers Lane, Rockville, MD 20857

requirements equivalent to this Standard as indicated in each section shall be acceptable for drinking water applications without separate evaluation under this Standard.[11]

1.5 Alternate products or materials

While specific materials are stipulated in this Standard, drinking water system products or components that incorporate alternate materials shall be acceptable when it is verified that the product or component meets the applicable requirements of the Standard based on its end use.

2 Definitions

Terms used in this Standard that have a specific technical meaning are defined here.

2.1 analytical summary: A list of the analytes and analytical procedures, both chemical and microbiological, which are selected to determine whether a product is compliant to the requirements of the Standard; analytes may be either product specific or formulation dependent.

2.2 at the tap: Referring to the point-of-delivery or point-of-use for drinking water.

2.3 cold water application: A product application that is not intended to result in exposure for extended periods to water in excess of ambient water temperature.

2.4 contaminant: Any physical, chemical, biological, or radiological substance or matter in water.

NOTE – Consistent with the definition in the Federal Safe Drinking Water Act, a contaminant can have either a beneficial or detrimental effect on the potability of water.

2.5 direct additives: A treatment chemical and its contaminants directly added to water during the production of drinking water.

2.6 distribution system: The system of conduits or the network of pipelines (located primarily in the streets) through which a primary domestic water supply is distributed to consumers. In plumbing codes, this term is applied to all the hot and cold water piping installed in buildings.

2.7 drinking water: Water intended for human consumption.

2.8 good manufacturing practices: The practice of maximizing the purity of products and materials by maintaining and practicing appropriate quality control and quality assurance procedures.

2.9 hot water application: A product application that is intended to result in exposure for extended periods to water that has been raised from ambient temperature

2.10 indirect additives: Contaminants that are extracted into drinking water through contact with the surfaces of materials, components, or products used for its treatment, storage, transmission, or distribution.

2.11 manufacturer: A corporation, company, or individual that produces, formulates, packages, or repackages products, components, and materials that are intended to be in contact with drinking water

2.12 maximum contaminant level (MCL): The maximum concentration of a regulated contaminant that is permitted in a public drinking water supply, as defined under the Federal Safe Drinking Water Act

[11] Final acceptance of a product for drinking water application is the responsibility of the appropriate federal, state, or local regulatory agent.

NOTE – If the manufacturer requests review to relevant alternate regulatory requirements, the certifying agency can consider alternative regulatory levels, e.g., Canadian Maximum Acceptable Concentrations (MACs).

2.13 normalization: The process of adjusting laboratory extraction results by accounting for differences between laboratory and field surface area-to-volume ratios to reflect the contaminant concentration at the tap.

2.14 normalized concentration: A value for a contaminant concentration from a laboratory extraction test that has been adjusted to reflect the potential contaminant concentration at the tap.

2.15 point-of-entry system: A system with an inlet connection of 25.4 mm (1 in) or less that contacts all or a majority of the water entering the facility.

2.16 point-of-use system: A system located at a single tap or multiple taps that does not contact the majority of water entering the building or residence.

2.17 short-term exposure level (STEL): A maximum concentration of a contaminant that is permitted in drinking water for an acute exposure calculated in accordance with annex A of this Standard.

2.18 single product allowable concentration (SPAC): The maximum concentration of a contaminant in drinking water that a single product is allowed to contribute as defined by annex A of this Standard.

2.19 total allowable concentration (TAC): The maximum concentration of a nonregulated contaminant allowed in a public drinking water supply as defined by annex A of this Standard.

2.20 transmission system: A system of conduits through which a primary water supply is transmitted to the distribution system.

3 General requirements

3.1 General

3.1.1 Product and material information described in 3.2 shall be used to determine the specific section (4 through 9) under which a product or material shall be evaluated.

3.1.2 Products or materials whose intended uses fall under more than one section of this Standard shall be evaluated under the section having the most rigorous evaluation conditions.

NOTE – Rigorous conditions are typically associated with shorter conditioning periods, longer exposure periods, higher surface area-to-volume ratios, and higher exposure temperatures

3.2 Information and formulation requirements

The following information shall be reviewed to determine the appropriate analytical testing and to ensure that the potential health effects of products or materials are accurately and adequately identified:

- the product section(s) under which the product, component, or material is covered and the intended function or end use of the product or the material;
- for assembled products or components, a list of all of components and materials and their corresponding surface areas that come into direct contact with water;
- when appropriate, the total volume of water that the product can hold when filled to capacity;
- the expected service life of the product;

- the anticipated minimum, maximum, and average volumes of water that come into contact with the product, component, or material during a 24-h period;

- complete formulation information for each water contact material as applicable:

  - the composition of the formulation (e.g., percent or parts by weight for each chemical in the formulation or reference to a standardized material specification);

  - a chemical abstract number (CAS no.), name, trade designation, and supplier for each chemical present in the formulation and a Material Safety Data Sheet (MSDS), when available; and

  - an indication as to whether the chemical is an ingredient, reactant, or processing aid.

- the maximum temperature to which the product, component, or material is exposed during its intended end use;

- a description/classification of the manner in which the product or material is manufactured, handled, and packaged;

- when available, a list of the known or suspected impurities within the product or material and the maximum percent or parts by weight of each impurity;

- when available, the solubility, hydrolysis products, and extraction rates of chemicals within the product or material; and

- when available, a list of published and unpublished toxicological studies relevant to the chemicals and impurities present in the product, component, or material.

3.3 Identification of analytes

For all products and materials, the formulation information required in 3.2 shall be reviewed for completeness (e.g., all formulations total 100%), and to determine whether a minimum test battery has been established for each water contact material (see table 3.1). The availability of an established minimum test battery shall not preclude performance of a formulation review to identify any formulation-dependent analytes (see 3.3.1).

3.3.1 Formulation-dependent analysis selection

For all water contact materials, the formulation information described in 3.2 shall be reviewed, and formulation-dependent analytes shall be identified for each water contact material. The criteria for selection of a formulation dependent analyte shall include, but not be limited to, the following:

- known or suspected toxicity of the substance or its byproduct(s);

- high water solubility of the substance;

- monomer(s) of polymeric ingredients;

- high probability of extraction of a substance or its byproduct(s) at toxicologically significant concentrations; and

- extraction or migration information for the substance provided by the manufacturer.

3.3.2 Established minimum test batteries

The materials listed in table 3.1 shall be tested for the indicated analyses and any formulation-dependent analyses identified during the formulation-dependent analyte selection.

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3.4 Products manufactured from annex C acceptable materials

Products manufactured entirely from annex C materials shall not be required to undergo extraction testing for material-specific analytes of interest. However, extraction testing for contaminants contributed by processes specific to a production site shall be considered as formulation-dependent analytes. Annex C contains the evaluation requirements for qualification as an acceptable material.

Table 3.1 – Material-specific analyses

Material type	Required analyses
Pipe/fitting/device materials	
asphaltic-coated ductile iron	GC/MS base/neutral scan (specific for carbonyls and non-aromatic hydrocarbons)[1], volatile organic chemicals (VOCs), polynuclear aromatic hydrocarbons (PNAs), regulated metals[2], molybdenum, vanadium, manganese
brass	regulated metals[2], zinc, nickel
concrete	regulated metals[2]
copper	regulated metals[2]
galvanized steel	regulated metals[2], zinc, nickel
stainless steel	regulated metals[2], nickel
Plastic materials	
acetal (AC)/polyoxymethylene (POM)	formaldehyde, VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1], acetal oligomers (by GC/MS base/acid scan)[1]
acrylonitrile-butadiene-styrene (ABS)	acrylonitrile, 1,3-butadiene, styrene, regulated metals[2], VOCs, phenolics (by GC/MS base/acid scan)[1]
cross linked polyethylene (PEX)	GC/MS[1], VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1], methanol, *tert*-butyl alcohol[3]
nylon 6	caprolactam, nitrogen-containing extractants (by GC/MS base/neutral scan)[1], VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
other nylons	nitrogen-containing extractants (by GC/MS base/neutral scan)[1], VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1], nylon monomers
polybutylene (PB)	VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polyethylene (PE)	VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polyphenylene oxide (PPO)	dimethyl phenol, VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polyphthalamide (PPA)	hexamethylene diamine, terephthalic acid, isophthalic acid, VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polypropylene (PP)	VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polysulphone including poly[phenylene sulphone] (PPSU)	sulphone monomer, VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polyurethane (PUR)	GC/MS[1], VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1]
polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC)	regulated metals[2], phenolics[1], VOCs, tin[4], antimony[5], residual vinyl chloride monomer (RVCM)[6]
polyvinyl chloride (flexible)	VOCs, regulated metals[2], phenolics (by GC/MS base/acid scan)[1], phthalates[7], RVCM[6], tin[4], zinc[8]
Elastomer materials	
ethylene-propylene-diene monomer (EPDM)	GC/MS[1], VOCs, phenolics (by GC/MS base/acid scan)[1], phthalates[7], PNAs[1]
fluoroelastomer	GC/MS[1], VOCs, phthalates[7]
isoprene	GC/MS[1], VOCs, phenolics (by GC/MS base/acid scan)[1], phthalates[7], PNAs[1], isoprene monomer
neoprene	GC/MS[1], VOCs, phenolics (by GC/MS base/acid scan)[1], phthalates[7], PNAs[1], chloroprene
nitrile-butadiene rubber (NBR, BUNA-N)	GC/MS[1], VOCs, phenolics (by GC/MS base/acid scan)[1], phthalates[7], PNAs[1], 1,3-butadiene, acrylonitrile
styrene-butadiene rubber (SBR)	GC/MS[1], VOCs, phenolics (by GC/MS base/acid scan)[1], phthalates[7], PNAs[1], 1,3-butadiene, styrene

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Table 3.1 – Material-specific analyses

Material type	Required analyses
Barrier materials	
asphaltic coatings	regulated metals[2], molybdenum, vanadium, manganese, VOCs, GC/MS base/neutral scan (specific for carbonyls and non-aromatic hydrocarbons)[1], PNAs[1]
epoxy coatings (liquid and powder)	GC/MS (base/neutral/acid scan), bisphenol A, bisphenol A-diglycidyl ether[9], bisphenol A-diglycideryl ether[9], bisphenol A-propoxylate[9], epichlorohydrin, VOCs, solvent and reactive diluent additives[10]
polyester coatings	GC/MS (base/neutral/acid scan), VOCs, residual monomers[11]
polyurethane coatings	GC/MS (base/neutral/acid scan), VOCs
Portland and hydraulic cements	GC/MS[1], regulated metals[2], dioxins and furans, radionuclides, glycols and ethanolamines[12]

[1] see annex B, section B 7

[2] antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, thallium

[3] *tert*-Butyl alcohol analysis is required for PEX materials except those crosslinked via e-beam methodology

[4] The analysis for tin is required when tin-based stabilizers are used.

[5] The analysis for antimony is required when antimony-based stabilizers are used.

[6] The level of RVCM within the walls of PVC or CPVC products and materials shall be directly determined (annex B, section B 7)

[7] The analysis for phthalates is required when phthalate ester plasticizers are used. Analysis shall be for the specific phthalate ester(s) used in the formulation.

[8] The analysis for zinc is required when zinc-based stabilizers are used.

[9] Analysis shall be performed using liquid chromatography with ultraviolet detection (LC/UV).

[10] Analysis shall be performed for the specific solvent and reactive diluent additives used in the individual product formulation, such as benzyl alcohol

[11] Analysis shall be performed for residual concentrations of the specific ester monomers used in the individual product formulation.

[12] Glycol and ethanolamine analyses shall be performed on cements containing these compounds as grinding aids.

– concluded –

4 Pipes and related products

4.1 Scope

4.1.1 The requirements in this section apply to pipes and pipe-related products and the water-contact materials associated with these products. Pipe-related products include, but are not limited to, the following items: fittings, couplings, flexible and rigid tubing, riser tubing, dip tubes, hoses, well casings, drop pipes, screens, and pipe-related coatings.

4.1.2 Coatings and other barrier materials not exclusively intended for application to pipes or pipe-related products are evaluated under 5.

NOTE – Coatings and other barrier materials, which meet the requirements of 5 at a specific surface area-to-volume ratio, shall be considered to meet the requirements of a pipe or pipe-related product application for a surface area-to-volume ratio less than or equal to the ratio accepted under the 5 evaluation.

4.1.3 Individual ingredients of cement-based pipes and related products (including Portland and blended hydraulic cement and admixtures) are evaluated under 5.

4.1.4 Products and materials intended to join or seal pipes or pipe-related products are evaluated under 6.

4.2 Definitions

4.2.1 cold water application: A product application that is intended to result in continuous exposure to water of ambient temperature Products are tested for an end-use temperature of 23 ± 2 °C (73 ± 4 °F).

4.2.2 commercial hot water applications: A product application that is intended to result in continuous or intermittent exposure to water that has been raised from ambient temperature. Intermittent exposure is considered to be any hot water contact that is not continuous. Products are tested for an end-use temperature of 82 ± 2 °C (180 ± 3 °F).

4.2.3 domestic hot water applications: A product application that is intended to result in continuous or intermittent exposure to water that has been raised from ambient temperature. Intermittent exposure is considered to be any hot water contact that is not continuous Products are tested for an end-use temperature of 60 ± 2 °C (140 ± 3 °F).

4.2.4 nominal diameter: A designation system used to specify a pipe size, where the designation for a specific size is approximately equal to the average inside diameter of the pipe.

4.3 General requirements

4.3.1 The product size with the most conservative normalization condition shall be evaluated. Successful evaluation of such product shall qualify all products of less conservative normalization conditions, provided the materials of construction are identical as specified in 4 4 1.

NOTE – For products of 1 3 cm to 10 cm (0.5 in to 4 in) nominal diameter and products of 10 cm diameter and greater (4 in diameter and greater), the most stringent normalization condition is typically the smallest inner diameter product within the nominal diameter range. Products of less than 1.3 cm (0.5 in) nominal diameter are assumed to have limited exposure in the distribution system (see assumptions in tables 4.4 and 4.5) Successful qualification of products of less than 1.3 cm (0.5 in) nominal diameter may not demonstrate the acceptability of all products 1.3 cm (0.5 in) nominal diameter and greater

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4.3.2 Residual vinyl chloride evaluation

Polyvinyl chloride and chlorinated polyvinyl chloride products and materials shall be evaluated for the level of residual vinyl chloride monomer (RVCM) in the product wall or in the material according to annex B, section B 7.

4.4 Sample requirements

4.4.1 General

A sample can represent a product line of various sizes when:

- materials are of the same alloy, composition, or formulation;
- materials have undergone the same manufacturing process, e.g., casting, extrusion;
- designs and manufacturing processes are analogous; and/or
- it has the most stringent normalization requirements (see 4.3.1).

4.4.2 Materials

When a material is proposed for evaluation, a representative sample of the material shall be used Material test samples (e.g., plaque or sheet) shall be used only if no chemical or physical difference exists between the material sample and the material as it is used in applications covered by 4 A material intended to be processed by more than one method (e.g., injection molding, extrusion, stamping, etc) shall be tested in each of its processed forms.

4.4.3 Finished products

When a finished product (e.g., pipe or fitting) is proposed for evaluation, a sample of the finished product shall be used for testing except in the following specific instances:

- concrete cylinders, cubes, or other concrete surrogate samples can be evaluated on behalf of concrete-lined pipes and other concrete-based products;

- coatings, applied to the appropriate substrate, can be evaluated on behalf of products whose entire water contact surface is covered by the coating; or

- finished products, for which finished product evaluation is impractical due to one or more of the following reasons, shall be permitted to be evaluated using material samples:

  - an internal volume greater than 20 L (5 3 gal);
  - a weight greater than 34 kilograms (75 lb); or
  - *in situ* manufacture of the finished product

Material samples shall be permitted to be evaluated on behalf of a finished product, if the first and second criteria listed under 4.4.1 are satisfied.

4.5 Extraction procedures

4.5.1 Analytical summary

An analytical summary shall be prepared for each product or material. The analytical summary shall consist of the formulation-dependent analytes identified in 3 2 and the applicable material-specific analytes listed in table 3.1.

4.5.2 Preparation of test samples

4.5.2.1 In all cases, test samples shall be prepared so that the laboratory surface area-to-volume ratio is equal to or greater than the surface area-to-volume ratio at which the product is intended to be used in the field.

NOTE – To facilitate the exposure of product samples that are connected to pipe or tubing products under normal installation conditions (e.g., fittings), the samples may be attached to lengths of pipe or tubing of the appropriate nominal diameter. When preparing a test sample in this manner, the exposed surface area of the fitting test sample shall represent a percentage of the total exposed surface area (test sample plus the attached pipe or tubing) that is equal to or greater than the percentage specified in the table 4.5 normalization assumptions, for the specific nominal diameter and end use of the product (flexible or rigid piping system). The pipe or tubing material shall also be present in the method blank as required in annex B, section B.2.8.1.

4.5.2.2 Unless manufacturer's instructions direct otherwise, test samples shall be rinsed in cold tap water until any extraneous debris or contamination that occurred during shipping and handling is removed. The samples shall then be rinsed in reagent water, meeting the requirements of annex B, section B.9.2.1

4.5.2.3 If the exterior surface of a product is to be exposed, all markings, which are not integral to the product (e.g., ink markings), shall be removed.

4.5.2.4 When the test sample contains internal threaded outlets, 75% of the threaded surface area shall be covered by insertion of a threaded component of the appropriate diameter to produce a watertight seal.

4.5.3 Exposure water

4.5.3.1 General

Exposure water selection shall be determined by the analytes of interest identified on the analytical summary (see 4.5.1). Exposure water(s) shall be selected in accordance with annex B, section B.2 5.

4.5.3.2 Copper and copper alloys

Copper and copper alloy pipe and tubing shall be exposed in the pH 6.5 and in the pH 10 exposure waters as described in annex B, section B.9. Copper and copper alloy fittings intended to be used used with copper pipe and tubing shall be exposed in either the pH 5 or the pH 6.5 exposure waters (at the discretion of the manufacturer) and in the pH 10 exposure water, as described in annex B, section B.9 For all copper and copper alloy pipes, tubing, and fittings tested using the pH 6.5 exposure water, the manufacturer's literature shall indicate this use limitation. The manufacturer's use instructions or product literature that references this Standard shall indicate this use limitation by inclusion of the following statement:

"Copper [tube, pipe, or fitting] (Alloy [alloy designation]) has been evaluated by [Testing Organization] to NSF/ANSI 61 for use in drinking water supplies of pH 6.5 and above Drinking water supplies that are less than pH 6.5 may require corrosion control to limit leaching of copper into the drinking water."

4.5.4 Conditioning and exposure options

4.5.4.1 In-product conditioning and exposure

During in-product conditioning and exposure, the test sample shall be filled completely with exposure water The product having the greatest surface area-to-volume ratio (typically the smallest diameter) shall be preferentially used. When necessary to prevent the loss of exposure water, samples shall be capped with inert materials (e.g., glass).

4.5.4.2 In-vessel conditioning and exposure

During in-vessel conditioning and exposure, samples shall be placed in containers composed of a material that is inert to the exposure water having polytetrafluoroethylene lined lids. The exposure water shall completely immerse the sample. All samples shall be exposed at a surface area-to-volume ratio that is equal to or greater than that of the intended end use. The actual wetted surface area-to-volume ratio achieved during the exposure shall be recorded.

NOTE – The stated duration of the conditioning period at the hot temperature does not include any time needed to elevate the product sample or exposure vessel to the required exposure temperature

4.5.4.3 Multiple time point protocol

When the normalized concentration of a contaminant exceeds, or is expected to exceed, its acceptable level when evaluated as a single time point exposure (see 4 5 6), determination of the contaminant leaching rate as a multiple time point exposure shall be considered (see 4 5.7). For the purpose of contaminant concentration evaluation (see 4 8.2), Day 1 shall be defined as the time point at which extractant water is collected for analysis under the single time point exposure protocol in table 4.2 (17 d in elapsed time). Day 90 shall be defined as 90 d following this time point

NOTE – When employing a multiple time point protocol to the evaluation of a contaminant, consideration shall be given to the leaching characteristics of the contaminant, e.g., does the leaching pattern demonstrate a linear regression. Consideration shall also be given to the availability of appropriate toxicity data to define an acute exposure limit for the contaminant, as required in 4.8.2.

4.5.5 Single time point conditioning protocols

A separate sample shall be conditioned for each type of exposure water selected in 4.5.3.

4.5.5.1 Single time point conditioning – cold application

Products that are intended to be in contact with only cold water shall be conditioned in the exposure water(s) selected in 4.5.3 at 23 ± 2 °C (73 ± 4 °F) for 14 d. During the 14-d period, the exposure water shall be changed at least 10 times with a minimum period of 24 ± 1 h between water changes. The free available chlorine concentration during the conditioning period shall be 2 mg/L. After the 14-d conditioning period, the exposure water in the product or in the vessel shall be decanted and discarded. Shortened conditioning periods shall be used at the request of the manufacturer. Exposure of the sample according to 4.5.6 shall immediately follow conditioning.

NOTE – Table 4.1 provides an example single time point conditioning protocol. Alternate protocols shall be permitted as long as the requirements of 4.5.5.1 are met.

4.5.5.2 Single time point conditioning – hot applications

4.5.5.2.1 Intermittent hot water conditioning

Products that are intended to be in intermittent contact with hot water shall undergo the cold application conditioning according to 4.5.5.1. At the conclusion of the cold application conditioning, the products shall be further conditioned in the exposure water(s) selected in 4.5.3 at either 60 ± 2 °C (140 ± 3 °F) or 82 ± 2 °C (180 ± 3 °F) for two consecutive 60 ± 5 min periods. The exposure water shall be decanted and discarded after each 1-h period. Exposure of the sample according to 4.5.6 shall immediately follow completion of the further conditioning.

NOTE – The stated duration of the conditioning period at the hot temperature does not include any time needed to elevate the product sample or exposure vessel to the required exposure temperature.

4.5.5.2.2 Continuous hot water conditioning

Products that are intended to be in continuous contact with hot water shall be conditioned in the exposure water(s) selected in 4.5.3 at either 60 ± 2 °C (140 ± 3 °F) or 82 ± 2 °C (180 ± 3 °F) for 14 d During the 14-d period, the exposure water shall be changed at least 10 times with a minimum period of 24 ± 1 h between water changes. The free available chlorine concentration during the conditioning period shall be 2 mg/L After the 14-d conditioning period, the exposure water in the product or in the vessel shall be decanted and discarded Shortened conditioning periods shall be permitted at the request of the manufacturer Exposure of the sample according to 4.5.6 shall immediately follow conditioning.

NOTE – Table 4.1 provides an example single time point conditioning protocol. Alternate protocols shall be permitted as long as the requirements of 4.5.5.2 are met.

4.5.6 Single time point exposure protocols

Products to be evaluated at a single time point shall be exposed according to the schedule in table 4.2. The first two 24-h exposure periods shall be optional at the discretion of the manufacturer. A separate sample shall be exposed for each type of exposure water selected in 4.5.3. For each sample, the exposure water shall be of the same pH as the water used for conditioning of the sample

4.5.6.1 Single time point exposure – cold application

Immediately following conditioning, the product shall be exposed at 23 ± 1 °C (73 ± 2 °F) according to the schedule in table 4.2.

4.5.6.2 Single time point exposure – hot applications

4.5.6.2.1 Intermittent hot water exposure

Immediately following conditioning, the product shall undergo the cold application exposure according to 4.5 6 1 Prior to the final 16-h exposure, the product shall be exposed at the selected elevated temperature, either 60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F), for 30 ± 5 min. The product shall then be exposed at 23 ± 1 °C (73 ± 2 °F) for the duration of the exposure period. The exposure water shall not be decanted prior to initiation of the final 16-h exposure.

4.5.6.2.2 Continuous hot water exposure

Immediately following conditioning, the product (in-product exposures) or the exposure vessel (in-vessel exposures) shall be filled with fresh exposure water of the applicable pH (see 4.5.3). The product shall then be exposed at the selected elevated temperature, either 60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F), according to the schedule in table 4.2

4.5.7 Multiple time point conditioning/exposure protocols

For the purpose of determining a contaminant leaching rate as a function of time, extractant water samples shall be collected during the conditioning period of products for which multiple time point exposure has been elected, according to the protocols in 4.5.7.1 and 4.5.7.2. A separate sample shall be conditioned and exposed for each type of exposure water selected in 4.5.3.

4.5.7.1 Cold application

Products that are intended to be in contact with only cold water shall be maintained at 23 ± 1 °C (73 ± 2 °F) for 19 d. During the 19-d period, the exposure water shall be changed at least 12 times, with a minimum period of 24 ± 1 h between water changes. At seven of these water changes, extraction water shall be collected for analysis after a 24-h exposure. For extrapolation and normalization purposes, the number of

hours elapsed since the most recent water change (or sample collection) and the number of days elapsed since the initiation of the exposure shall be recorded at the time of each extraction water collection.

NOTE – Table 4.3 provides an example multiple time point conditioning/exposure protocol. Alternate protocols shall be permitted as long as the requirements of 4.5.7.1 are met.

At the discretion of the manufacturer, direct measurement of a Day 90 extraction shall be permitted. The products shall be maintained at 23 ± 1 °C (73 ± 2 °F). Extraction water shall be collected for analysis at a minimum of two time points: after Day 1 (representing 14 d of conditioning and 1 d of acute exposure), and after the final exposure terminating on Day 90 (representing 14 d of conditioning, 1 d of acute exposure, and 90 d of chronic exposure). The exposure water shall be changed at least 4 d per week during the interval between the initial and final exposures. Exposures that are used for the collection of extractant water for analysis shall not exceed 24 ± 1 h in duration.

4.5.7.2 Hot applications

4.5.7.2.1 Intermittent hot water exposure

Products that are intended to be in intermittent contact with hot water shall undergo the cold application exposure according to 4.5.7.1. At the initiation of each exposure that will be collected for analysis, the product shall be exposed at the selected elevated temperature, either 60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F), for 30 ± 5 min. The product shall then be exposed at 23 ± 1 °C (73 ± 2 °F) for the duration of the exposure period. The exposure water shall not be decanted prior to the completion of the exposure period.

NOTE 1 – Table 4.3 provides an example multiple time point conditioning/exposure protocol. Alternate protocols shall be permitted as long as the requirements of 4.5.7.2.1 are met.

NOTE 2 – The stated duration of the conditioning period at the hot temperature does not include any time needed to elevate the product sample or exposure vessel to the required exposure temperature.

At the discretion of the manufacturer, direct measurement of a Day 90 extraction shall be permitted. At the initiation of each exposure that will be collected for analysis, the products shall be exposed at the selected elevated temperature, either 60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F), for 30 ± 5 min. The product shall then be exposed at 23 ± 1 °C (73 ± 2 °F) for the duration of the exposure period. The exposure water shall not be decanted prior to the completion of the exposure period. Extraction water shall be collected for analysis at a minimum of two time points: after Day 1 (representing 14 d of conditioning and 1 d of acute exposure), and after the final exposure terminating on Day 90 (representing 14 d of conditioning, 1 d of acute exposure, and 90 d of chronic exposure). The exposure water shall be changed at least 4 d per week during the interval between the initial and final exposures. Exposures that are used for the collection of extractant water for analysis shall not exceed 24 ± 1 h in duration.

4.5.7.2.2 Continuous hot water exposure

Products that are intended to be in continuous contact with hot water shall be maintained at the selected elevated temperature, either 60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F) for 19 d. During the 19-d period, the exposure water shall be changed at least 12 times with a minimum period of 24 ± 1 h between water changes. At seven of these water changes, extraction water shall be collected for analysis after a 24-h exposure. For extrapolation and normalization purposes, the number of hours elapsed since the most recent water change (or sample collection) and the number of days elapsed since the initiation of the exposure shall be recorded at the time of each extraction water collection.

NOTE – Table 4.3 provides an example multiple time point conditioning/exposure protocol. Alternate protocols shall be permitted as long as the requirements of 4.5.7.2.2 are met.

At the discretion of the manufacturer, direct measurement of a Day 90 extraction shall be permitted. The products shall be maintained at the selected elevated temperature, either 60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C

(180 ± 2 °F). Extraction water shall be collected for analysis at a minimum of two time points: after Day 1 (representing 14 d of conditioning and 1 d of acute exposure), and after the final exposure terminating on Day 90 (representing 14 d of conditioning, 1 d of acute exposure, and 90 d of chronic exposure). The exposure water shall be changed at least 4 d per week during the interval between the initial and final exposures. Exposures that are used for the collection of extractant water for analysis shall not exceed 24 ± 1 h in duration.

4.5.8 Collection and preservation of extraction water

Immediately following exposure, extraction waters collected for analysis shall be poured into previously prepared sample containers for storage until analysis, as specified in annex B, section B.6.

4.6 Analysis

4.6.1 Extraction waters shall be analyzed with the methods listed in annex B, section B.7.

4.6.2 Samples requiring analysis for residual vinyl chloride monomer shall be evaluated according to the method in annex B, section B.7.

4.7 Normalization of contaminant concentrations

4.7.1 General

The concentration of analytes detected in the extraction water shall be multiplied by a calculated normalization factor (NF) to account for differences between laboratory and field surface area-to-volume ratios. The normalization factor shall be based on calculations and assumptions relevant to the end use of the product.

The general formula for the derivation of the normalization factor is described in the following equations:

$$NF = N1 \times N2$$

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}}$$

$$N2 = \frac{V_{F(static)}}{V_{F(flowing)}}$$

where:

SA_F = surface area exposed in the field;

SA_L = surface area exposed in the laboratory;

V_L = volume of extraction water used in the laboratory;

$V_{F(static)}$ = volume of water to which the product is exposed under static conditions; and

$V_{F(flowing)}$ = volume of water to which the product is exposed under flowing conditions during a period of time equivalent to the laboratory test.

When the length of the exposure being normalized is other than 16 h in length, the normalized value shall be adjusted to reflect a 16-h exposure (e.g., multiply the normalized value by 0.7 when a 24-h exposure was used). The nominal diameter of the product shall determine which assumptions are used for normalization

(see tables 4.4 and 4.5). The actual inner diameter of the product shall be used for the normalization calculations of surface area and volume.

NOTE – Adjustment of the normalized contaminant concentration for the duration of the exposure period shall consider the extraction kinetics of the contaminant under evaluation For contaminants that do not exhibit linear extraction kinetics, adjustment for the duration of exposure shall be done in accordance with the demonstrated kinetics of the contaminant or shall not be applied if this information is not available.

4.7.2 Products installed at regularly repeating intervals

For products installed at regularly repeating intervals (e.g., pipes, fittings), the SA_F shall be calculated from the assumed length of pipe corresponding to the segment of the system in which the product is used (e.g., 100 ft of pipe in the service line or 280 ft of pipe in the residence). The $V_{F(static)}$ component of the N1 term shall be the volume of water contained within the assumed length of pipe. For fittings, the actual inner diameter of the pipe used with the fittings shall be used to calculate both SA_F and $V_{F(static)}$.

4.7.3 Products not installed at regularly repeating intervals

Products not installed at regularly repeating intervals shall be identified through review of the manufacturer's recommended product end use. For products not installed at regularly repeating intervals (e g , transition fittings, repair couplings, drop ear elbow fittings, and copper stub outs), the SA_F shall be the wetted surface area of a single product. The $V_{F(static)}$ component of the N1 term shall be the volume of water a single product contains when filled to capacity, except that $V_{F(static)}$ shall equal 1 L (0.26 gal) for all products that contain less than 1 L (0.26 gal) of water when filled to capacity.

4.7.4 Sample calculations for normalization of products in 4 are provided in table 4.6.

4.7.5 Selection of normalization conditions

Pipe and fitting products of nominal diameter greater than or equal to 10 cm (4 in) shall be normalized to the flowing condition. Pipe and fitting products of nominal diameter of less than 10 cm (4 in) shall be normalized to the static condition when the value of N2 is less than or equal to 0.1. Pipe and fitting products of nominal diameter of less than 10 cm (4 in) shall be normalized to the flowing condition when the value of N2 is greater than 0.1.

4.7.6 Multiple time point exposure calculations

Laboratory values from each time point at which extractant water was collected (a minimum of five data points shall be required for extrapolation) shall be normalized as indicated in 4.7.1, depending on product end use A decay curve of these normalized contaminant concentrations in relation to elapsed exposure time shall be plotted. Contaminant concentrations shall be determined for two time points as follows: at Day 1 (representing 14 d of conditioning and 1 d of acute exposure) and at Day 90 (representing 14 d of conditioning, 1 d of acute exposure, and 90 d of chronic exposure) shall be extrapolated from this curve (see 4.5.7).

If direct measurement of a Day 90 exposure has been performed, laboratory values from each time point at which extractant water was collected (a minimum of two time points as defined in 4.5.7.1 and 4.5.7.2) shall be normalized as indicated in 4.7.1, depending on product end use.

4.8 Evaluation of contaminant concentrations

4.8.1 Contaminants measured in a single time point extraction

For pipe and fitting products, normalized static contaminant concentrations shall be no greater than their respective MCLs or TACs, and normalized flowing contaminant concentrations shall be no greater than their respective SPACs calculated in accordance with annex A.

4.8.2 Contaminants measured in a multiple time point extraction

Normalized Day 1 contaminant concentrations shall not exceed the short-term exposure level (STEL) as defined in annex A, section A 5

Normalized extrapolated or directly measured Day 90 contaminant concentrations shall not exceed the limits defined in 4 8 1

4.8.3 Residual vinyl chloride monomer (RVCM)

The average RVCM concentration shall be less than or equal to 3.2 mg/kg as evaluated in the product wall.

Table 4.1 – Example single time point conditioning schedule

Conditioning time	Elapsed time	Comment
24 ± 1 h	1 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued.
24 ± 1 h	2 d	Exposure water is decanted and discarded, the exposure vessel or product is refilled with exposure water and conditioning is continued.
24 ± 1 h	3 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued.
24 ± 1 h	4 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued
72 ± 1 h	7 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued
24 ± 1 h	8 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued.
24 ± 1 h	9 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued.
24 ± 1 h	10 d	Exposure water is decanted and discarded, the exposure vessel or product is refilled with exposure water and conditioning is continued.
24 ± 1 h	11 d	Exposure water is decanted and discarded; the exposure vessel or product is refilled with exposure water and conditioning is continued.
72 ± 1 h	14 d	Exposure water is decanted and discarded; conditioning is terminated.

Table 4.2 – Single time point exposure schedule

Exposure time	Elapsed time[1]	Comment
24 ± 1 h (optional)	15 d (optional)	Extraction water is decanted and discarded; the exposure vessel or product is refilled with exposure water and exposure is continued
24 ± 1 h (optional)	16 d (optional)	Extraction water is decanted and discarded; the exposure vessel or product is refilled with exposure water and exposure is continued.
16 h	17 d (15 d if the two optional exposure periods are not elected)	Extraction water is collected for analysis.

[1] Elapsed time indicated includes the 14 d of conditioning preceding the exposure.

Table 4.3 – Example multiple time point conditioning/exposure schedule

Exposure time	Elapsed time	Sample collection
24 ± 1 h	1 d	Extraction water is collected for analysis at completion of the exposure period; the product or exposure vessel is refilled with exposure water and the exposure is continued.
24 ± 1 h	2 d	Extraction water is collected for analysis at completion of the exposure period; the product or exposure vessel is refilled with exposure water and the exposure is continued.
24 ± 1 h	3 d	Extraction water is decanted and discarded; the product or exposure vessel is refilled with exposure water and the exposure is continued.
24 ± 1 h	4 d	Extraction water is collected for analysis at completion of the exposure period; the product or exposure vessel is refilled with exposure water and the exposure is continued.
72 ± 1 h	7 d	Extraction water is decanted and discarded; the product or exposure vessel is refilled with exposure water and the exposure is continued
24 ± 1 h	8 d	Extraction water is collected for analysis at completion of the exposure period; the product or exposure vessel is refilled with exposure water and the exposure is continued.
24 ± 1 h	9 d	Extraction water is decanted and discarded; the product or exposure vessel is refilled with exposure water and the exposure is continued.
24 ± 1 h	10 d	Extraction water is collected for analysis at completion of the exposure period; the product or exposure vessel is refilled with exposure water and the exposure is continued.
96 ± 1 h	14 d	Extraction water is decanted and discarded, the product or exposure vessel is refilled with exposure water and the exposure is continued.
24 ± 1 h	15 d	Extraction water is collected for analysis at completion of the exposure period; the product or exposure vessel is refilled with exposure water and the exposure is continued.
72 ± 1 h	18 d	Extraction water is decanted and discarded; the product or exposure vessel is refilled with exposure water and the exposure is continued
24 ± 1 h	19 d	Extraction water is collected for analysis at completion of the exposure period; the exposure is terminated.

Table 4.4 – Pipes – normalization factors and assumptions

Product nominal diameter	Assumptions	Exposure type	N1	N2 (flowing condition)
non-copper pipe nominal ≥ 10 cm (4 in)	– water is exposed to the same material from the treatment plant to the service line – a 16-h exposure period is evaluated	in-product	1	1
		in-vessel	calculated according to 4.7.1	1
10 cm (4 in) > nominal ≥ 1.3 cm (0.5 in)	– a 16-h exposure period is evaluated – residential water usage is 681 L (180 gal) per 24 h – 100 ft of service line from water main to residence	in-product	1	calculated according to 4.7.1
		in-vessel	calculated according to 4.7.1	calculated according to 4.7.1
nominal < 1.3 cm (0.5 in)	– a maximum run of 7.6 m (25 ft) of small diameter product is installed – for products with an internal volume less than 1 L, $V_{F(static)}$ is set equal to 1 L – a 16-h exposure period is evaluated – residential water usage is 681 L (180 gal) per 24 h – 280 ft per residence (140 ft each for hot and cold sides)	in-product	1	calculated according to 4.7.1
		in-vessel	calculated according to 4.7.1	calculated according to 4.7.1
copper pipe ≥ 10 cm (4 in)	– utilized as main distribution lines within buildings[1] – a 16-h exposure period is evaluated	in-product	1	0.55
		in-vessel	calculated according to 4.7.1	0.55

[1] The N2 value for copper products used as main distribution lines in buildings was calculated based on the static volume of a piping network of up to 20 miles and an average flow of 100 gpm.

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Table 4.5 – Fittings (installed at regular intervals) – normalization factors and assumptions

Product nominal diameter	Assumptions	Exposure type	N1	N2 (flowing condition)
Nominal ≥ 10 cm (4 in)	– water is exposed to the same material from the treatment plant to the service line – fittings represent 2% of the distribution system surface area – a 16-h exposure period is evaluated	in-product	0 02	1
		in-vessel	calculated according to 4.7.1 and multiplied by 0.02	1
10 cm (4 in) > nominal ≥ 1.3 cm (0.5 in)	– fittings represent 2% of the piping system for products 10 cm (4 in) > nominal ≥ 2.5 cm (1.0 in) (rigid and flexible systems) – fittings represent 6% of the piping system surface area for products 2.5 cm (1.0) in > nominal ≥ 1.3 cm (0.5 in) (rigid systems)[1] – fittings represent 3% of the piping system surface area for products 2.5 cm (1.0) in > nominal ≥ 1.3 cm (0.5) in (flexible systems)[1] – a 16-h exposure period is evaluated – residential water usage is 681 L (180 gal) per 24 h – 100 ft of service line from water main to residence	in-product	0.02, 0.06, or 0.03 depending on product diameter and end use (flexible or rigid system)	calculated according to 4.7.1
		in-vessel	calculated according to 4.7.1 and multiplied by 0.02, 0.06, or 0.03 depending on product diameter and end use (flexible or rigid system)	calculated according to 4.7.1
nominal < 1.3 cm (0.5 in)	– a maximum run of 7.6 m (25 ft) of small diameter product is installed – fittings represent 6% of the residential system surface area for rigid piping systems[1] – fittings represent 3% of the residential system surface area for flexible piping systems[1] – a 16-h exposure period is evaluated – residential water usage is 681 L (180 gal) per 24 h – 280 ft of pipe per residence (140 ft) each for hot and cold sides)	in-product	0.06 or 0.03 depending on product end use (flexible or rigid system)	calculated according to 4.7.1
		in-vessel	calculated according to 4.7.1 and multiplied by 0.06 or 0 03 depending on product end use (flexible or rigid system)	calculated according to 4.7.1

[1] For products that may be used with either rigid or flexible systems, fittings shall be assumed to represent 6% of the piping system surface area.

Table 4.6 – Example normalization calculations

In-product exposure of a 30.5 cm (1 ft) length of 15.2 cm (6 in) i.d. pipe	
Parameters: SA_F = 1459 cm^2 (226 in^2) SA_L = 1459 cm^2 (226 in^2) $V_{F(static)}$ = 5.6 L (1.5 gal) V_L = 5.6 L (1.5 gal)	normalized flowing concentration = $\frac{226\ in^2}{226\ in^2}$ x $\frac{1.5\ gal}{1.5\ gal}$ x 1 x laboratory concentration
In-vessel exposure of a 2.5 cm (1 in) i.d. pipe	
Parameters: SA_F/ $V_{F(static)}$ = 1575 cm^2/1 L (924 in^2/1 gal) SA_L= 247 in^2 (1 594 cm^2) V_L = 0.2 gal (0.8 L)	normalized static concentration = $\frac{924\ in^2}{247\ in^2}$ x $\frac{0.2\ gal}{1\ gal}$ x laboratory concentration
In-product exposure of a 63.5 cm (25 ft) length of 0.6 cm (0.25 in) i.d. pipe	
Parameters: SA_F = 1520 cm^2 (235.6 in^2) SA_L = 1520 cm^2 (235 6 in^2) $V_{F(static)}$ = 0.24 L (0 064 gal) – default to 1 L (0 26 gal) V_L = 0.24 L (0.064 gal)	normalized static concentration = $\frac{235.6\ in^2}{235.6\ in^2}$ x $\frac{0.064\ gal}{0.26\ gal}$ x laboratory concentration
In-product exposure of a 25.4 (10 in) long 15.2 (6 in) i.d. fitting	
Parameters: SA_F = 1216.1 cm^2 (188.5 in^2) SA_L = 1216.1 cm^2 (188.5 in^2) $V_{F(static)}$ = 4.6 L (1.2 gal) V_L = 4 6 L (1.2 gal)	normalized flowing concentration = $\frac{188.5\ in^2}{188.5\ in^2}$ x $\frac{1.2\ gal}{1.2\ gal}$ x 1 x 0.02 x laboratory concentration
In-vessel exposure of a 1.3 cm (0.5 in) i.d. fitting used with flexible piping systems	
Parameters: SA_F/ $V_{F(static)}$ = 3040 cm^2/1 L (1885 in^2/1 gal) SA_L = 1594 cm^2 (247 in^2) V_L = 0.8 L (0.2 gal)	normalized static concentration = $\frac{1885\ in^2}{247\ in^2}$ x $\frac{0.2\ gal}{1\ gal}$ x 0.03 x laboratory concentration
In-vessel exposure of a 0.6 cm (0.25 in) i.d. fitting used with rigid piping systems	
Parameters: SA_F / $V_{F(static)}$ = 908 in^2/1 gal (1523 cm^2/1 L) SA_L = 865 in^2 (5 581cm^2) $V_{F(static)}$ = 0.064 gal (0.24 L) – default to 0.26 gal (1 L) V_L = 0.4 gal (1.3 L)	normalized static concentration = $\frac{236\ in^2}{865\ in^2}$ x $\frac{0.4\ gal}{0.26\ gal}$ x 0.06 x laboratory concentration
In-vessel exposure of a 1.3 cm (0.5 in) i.d. fitting used as a repair coupling	
Parameters: SA_F / $V_{F(static)}$ = 3040 cm^2/1 L (1885 in^2/1 gal) $V_{F(static)}$ = 0.003 L (0.0009 gal) default to 1 L (0 26 gal) SA_L = 5581cm^2 (865 in^2) V_L = 1.3 L (0 4 gal)	normalized static concentration = $\frac{1.6\ in^2}{865\ in^2}$ x $\frac{0.4\ gal}{0.26\ gal}$ x laboratory concentration
NOTE – Definitions for SA_F, SA_L, $V_{F(static)}$, $V_{F(flowing)}$, and V_L are found in 4.7.1.	

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5 Barrier materials

5.1 Scope

The requirements of this section apply to products and materials intended to form a barrier providing containment of drinking water or to prevent drinking water contact with another surface. The products and materials that are covered include, but are not limited to: non-residential storage tanks, coatings, paints, linings and liners, bladders, diaphragms, and constituents of concrete and cement-mortar (e.g., Portland and blended hydraulic cements, admixtures, sealers, and mold release agents). These products and materials can be field-applied, factory-applied, precast, or cast in place.

5.2 Definitions

5.2.1 admixture: A material other than water, aggregates, hydraulic cement, and fiber reinforcement used as an ingredient of concrete or mortar and added to the batch immediately before or during its mixing.

5.2.2 aggregate: Granular material, such as sand, gravel, or crushed stone used with a cementing medium to form hydraulic-cement concrete or mortar.

5.2.3 barrier material: A material in contact with drinking water that serves a containment or separation purpose.

5.2.4 blended hydraulic cement: A hydraulic cement consisting of two or more inorganic constituents (at least one of which is not Portland cement or Portland cement clinker) that separately or in combination contribute to the strength-gaining properties of the cement.

5.2.5 coating/paint: A material applied to a surface where a direct bond to the substrate is formed.

5.2.6 concrete: A composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate; in hydraulic-cement concrete, the binder is formed from a mixture of hydraulic cement and water.

5.2.7 diaphragm/bladder: A flexible membrane that separates the surrounding media from the drinking water.

5.2.8 form/mold release agent: A material applied to the inside of a form or mold used to cast concrete or cement-mortar, which prevents adhesion of the concrete or cement-mortar to its surface.

5.2.9 hydraulic cement: A cement that sets and hardens by chemical interaction with water and that is capable of doing so under water.

5.2.10 liners/linings: Prefabricated materials applied, bonded, or attached to a surface that is subject to direct/indirect contact with drinking water.

5.2.11 mortar: A mixture of water, cement, and sand.

5.2.12 Portland cement: A hydraulic cement (usually containing calcium sulfate) produced by pulverizing Portland cement clinker (a partially fused substance consisting primarily of hydraulic calcium silicates).

5.2.13 sealer: A liquid that is applied as a coating to the surface of hardened concrete or cement-mortar, either to prevent or decrease the penetration of liquid or gaseous media during service exposure.

5.3 General requirements

5.3.1 Product labeling

Products or product containers shall be marked and include, at a minimum, product identification, batch number, or date of manufacture. When it is not feasible to mark the product or material, the manufacturer shall maintain identification records

5.3.2 Paints and coatings

For all paints and coatings, the manufacturer shall submit detailed use instructions. Use instructions shall specify the appropriate preparation and application procedures, including order of application for multiple layer systems, substrate preparation (including use of specific primer), subcomponent mixing, induction time, thinning, application method, application thickness(es), curing schedule, and final cure time prior to water immersion.

Coating systems that are composed of multiple products (e.g., primer, intermediate coat(s), and top coat, including any thinners) shall be evaluated as an applied system.

5.4 Sample requirements

When required for evaluation, a sample of the product or material equivalent to that used in field applications shall be obtained.

A single sample can represent a product line of similar formulations (e.g., different colors of the same coating product line) when:

- the sample selected for testing contains all of the formulation ingredients of toxicological concern (see 3.2) at concentrations equal to or greater than the products it is selected to represent; and

- product application conditions for the sample selected for testing (e.g., application thickness(es), cure times, solvent concentrations) are equal to or more severe than the products it is selected to represent; and

- for multiple component formulations, the mixing ratio(s) of the selected sample is(are) identical to that of the products it represents.

5.4.1 Cement samples

Cement samples, weighing a minimum of 9 kg (20 lbs), shall be collected in accordance with the applicable sections of ASTM C 183. To minimize contamination, all sample collection tools shall be cleaned and wiped with isopropyl alcohol before use. Collected samples shall be placed in moisture-proof containers. To minimize organic contamination, sample containers shall not be filled near a running motor or any type of exhaust system.

5.4.2 Concrete cylinder samples

Concrete test cylinders for the evaluation of cast-in-place or precast concrete structures shall be submitted with specific information on the composition of the concrete mix design for the specific installation, including the specific sources of cement, aggregate, admixtures, and any other additives. Specific information on the tank dimensions and water storage capacity shall also be provided. Concrete batch tickets, collected at the site of production, shall serve as evidence of the concrete mix actually used in the structure being evaluated.

5.4.3 Other barrier materials

Samples of barrier materials shall be collected at the point of manufacture.

5.5 Extraction procedures

5.5.1 Analytical summary

An analytical summary shall be prepared for each product. The analytical summary shall consist of the formulation-dependent analytes identified through the formulation review (see 3.2) and the applicable product-specific analytes listed in table 3.1.

5.5.2 Preparation of test samples

5.5.2.1 In all cases, test samples shall be prepared such that a minimum surface area-to-volume ratio of 50 cm^2/L (29 in^2/gal) is achieved during the exposure, and so that the entire surface to be exposed is covered by exposure water. Samples shall be rinsed with cold tap water and then in reagent water, meeting the requirements of annex B, section B.9.2.1 unless manufacturer's instructions direct otherwise

5.5.2.2 Field-applied paint and coating systems

These products shall be applied in accordance with the manufacturer's published use instructions (see 5.3 2) under the supervision of the certifying agency. Products shall be applied to a glass slide when appropriate. Products requiring a reactive substrate shall be applied to the appropriate alternate substrate Coating products shall be applied using application conditions as specified by the manufacturer in the product use instructions, e.g., the highest recommended percentage of thinner, the shortest curing period between coats or layers, the recommended film thickness per coat, and the shortest final curing period prior to immersion.

Multiple layer paint and coating systems that require the application of distinct coating product formulations in sequence shall be applied in a stepped manner so as to expose all layers Multiple coats of the same product (of the same color) applied in sequence shall not constitute multiple layers and shall not be applied in a stepped manner. Multiple coats of the same product (of different colors) applied in sequence shall not constitute multiple layers and shall not be applied in a stepped manner, unless deemed necessary by the testing laboratory to address potential health effects concerns from the differences in color formulations. Stepped coating systems shall be applied per the dimensions in table 5 1.

5.5.2.3 Factory-applied or cured systems

Paint and coating systems requiring factory application, factory curing, or both, shall be prepared in accordance with the manufacturer's published use instructions under the supervision of the certifying agency. These products shall be applied in accordance with the manufacturer's published use instructions (see 5.3.2). Products shall be applied to a glass slide when appropriate Products requiring a reactive substrate shall be applied to the appropriate alternate substrate Coating products shall be applied using application conditions as specified by the manufacturer in the product use instructions, e.g., the highest recommended percentage of thinner, the shortest curing period between coats or layers, the recommended film thickness per coat, and the shortest final curing period prior to immersion

Multiple layer paint and coating systems, which require the application of distinct coating product formulations in sequence, shall be applied in a stepped manner so as to expose all layers. Multiple coats of the same product (of the same color) applied in sequence shall not constitute multiple layers and shall not be applied in a stepped manner Multiple coats of the same product (of different colors) applied in sequence shall not constitute multiple layers and shall not be applied in a stepped manner, unless deemed necessary by the testing laboratory to address potential health effects concerns from the differences in color formulations. Stepped coating systems shall be applied per the dimensions in table 5.1.

NOTE – It is recognized that a coating system may be applied using a combination of factory and field application techniques. This is considered acceptable as long as the coating system is tested to the manufacturer's recommended application conditions, as specified in 5.5.2.2 and 5.5.2.3.

5.5.2.4 Products requiring cement mortar cubes

Test sample mortar cubes shall be prepared in accordance to the applicable sections of ASTM C 109. Mix water shall meet reagent water requirements (see annex B, section B.9.2.1). Sand shall be washed in accordance with the procedures in ASTM C 778 Mixing tools and other items coming into contact with the mortar shall be washed with soap and water, rinsed with tap water, rinsed with reagent water, and rinsed with isopropyl alcohol. The mortar shall be placed in polyethylene or polypropylene lined molds; no form release agents shall be used. Specimens shall be removed from the molds after 24 h and placed in glass or polyethylene beakers and covered with an inverted watch glass supported on glass Rebel hooks (or other devices to prevent air seal of the vessel) and placed for 28 d ± 12 h, or fewer as specified by the manufacturer, in a moist cabinet meeting the requirements of ASTM C 511. The specimens shall be removed from the moist cabinet and air dried at 23 ± 2 °C (73 ± 4 °F) and 50 ± 2% relative humidity for 7 d.

5.5.2.4.1 Portland and hydraulic cements

Test cubes for Portland and blended hydraulic cements shall be prepared in accordance with 5.5.2.4.

5.5.2.4.2 Admixtures

These products shall be added to the cement-mortar or concrete mixture using the manufacturer's highest recommended admixture dosage. The test samples shall be prepared as described in 5.5.2.4.

5.5.2.4.3 Sealers

These products shall be applied per manufacturer's recommendations to the test cubes prepared in accordance with 5.5.2.4. The coated cubes shall be allowed to cure for the manufacturer's recommended time period.

5.5.2.4.4 Form and mold release agents

These products shall be applied per manufacturer specifications to the mold used during the preparation of the test cubes (see 5.5.2.4).

5.5.2.5 Concrete water storage tanks

Concrete test cylinders (4" x 8") shall be prepared according to ASTM C 31 or ASTM C 192, and moist cured in an ASTM C 511 cabinet for a minimum of 3 d. Cylinder molds shall be manufactured of virgin materials free of detectable concentrations of any interfering contaminants

5.5.3 Exposure water

Exposure water selection shall be determined by the analytes of interest identified on the analytical summary (see 5.5.1). Exposure water(s) shall be selected in accordance with annex B, section B.2.5.

5.5.4 Conditioning

Test samples shall be conditioned immediately after curing This conditioning procedure simulates the disinfection of water storage tanks prior to placing into service The method described is based on Method 2 of AWWA Standard C652-92.

1) prepare 200 mg/L available chlorine solution using sodium hypochlorite (NaOCl - reagent grade or equivalent);

2) using a spray bottle, spray the previously rinsed test samples, wetting all surfaces to be exposed;

3) let the test samples stand for at least 30 min; and

4) place the test samples in racks, rinse with cold tap water, and rinse with reagent water, meeting the requirements of annex B, section B.9.2.1.

5.5.5 Exposure protocols

For all test samples, exposure shall commence immediately following the conditioning step. If immediate exposure is not possible, the test samples shall be dried in a laminar flow hood and exposed within 4 h. Successful evaluation at an elevated exposure temperature shall preclude testing at a lower exposure temperature. A separate sample shall be exposed for each type of exposure water selected in 5.5.3.

The exact surface area-to-volume ratio achieved during the exposure shall be recorded.

5.5.5.1 Cold application

Cold application product samples, as designated by the manufacturer, shall be placed in an exposure vessel and completely covered with exposure water of the applicable pH (see 5.5.3). The exposure vessel shall be placed in a 23 ± 2 °C (73 ± 4 °F) environment for the duration of the exposure period.

5.5.5.2 Domestic hot application

Products that are intended for domestic hot applications as designated by the manufacturer (e.g., for use in single-family dwellings) shall be placed in an exposure vessel and completely covered with exposure water of the applicable pH (see 5.5.3). The exposure vessel shall be placed in a 60 ± 2 °C (140 ± 4 °F) environment for the duration of the exposure period.

5.5.5.3 Commercial hot application

Products that are intended for commercial hot applications, as designated by the manufacturer, (e.g., for use in multiple-family dwellings, restaurants, hospitals) shall be placed in an exposure vessel and completely covered with exposure water of the applicable pH (see 5.5.3). The exposure vessel shall be placed in an 82 ± 2 °C (180 ± 4 °F) environment for the duration of the exposure period.

5.5.5.4 Single time point exposure protocol

When normalized contaminant concentrations from the product are expected to be less than their acceptable concentrations (see annex A) when tested at a single time point (e.g., flexible membrane liners), the product shall be exposed according to the protocol in table 5.2. Extraction water samples shall be collected at the conclusion of the final exposure period.

5.5.5.5 Multiple time point exposure protocol

When the normalized concentration of a contaminant exceeds, or is expected to exceed, its acceptable concentration (see annex A) when evaluated as a single time point (see 5.5.5.4), determination of the contaminant leaching rate as a function of time shall be considered. The relationship between contaminant concentration(s) and time shall be determined and plotted using a minimum of five data points. Table 5.3 summarizes the multiple time point exposure sequence. For contaminants of interest that do not require over time testing, extraction water shall be collected following the third exposure period (elapsed time 5 d).

5.5.6 Collection and preservation of extraction water

Immediately following the exposure period, the extraction water shall be poured into previously prepared sample containers for storage as detailed in annex B, section B.6, until analysis. Extraction water for solvent analysis shall be collected in a sample bottle containing sodium thiosulfate in a quantity sufficient to neutralize any residual chlorine, if applicable.

5.6 Analysis of extraction water

Extraction waters shall be analyzed with the methods listed in annex B, section B.8.

5.7 Normalization

5.7.1 Normalization for tanks/storage vessels

5.7.1.1 The following equation shall be used to calculate the normalized concentration of each contaminant for tanks or other storage vessels:

$$\text{normalized contaminant concentration} = \text{laboratory contaminant concentration} \times \frac{SA_F}{V_F} \times \frac{V_L}{SA_L} \times \frac{24\ \text{h}}{\text{hours of exposure}}$$

where:

SA_F/V_F = Surface area to volume ratio for the specified tank capacity, as defined in table 5.4
SA_L = Surface area exposed in the laboratory
V_L = Volume of extraction water used in the laboratory

When the length of the exposure being normalized is other than 24 h in length, the normalized value shall be adjusted to reflect a 24-h exposure.

Products used as barriers for tanks or storage vessels shall use the surface area-to-volume ratios shown in table 5.4. Surface area-to-volume ratios for products used as barriers in tanks or storage vessels with a capacity other than those shown in table 5.4 shall be determined on a case-by-case basis, as described in 5.7.1.2.

5.7.1.2 Calculation of the surface area-to-volume ratio for tanks or storage vessels

The following assumptions shall be used in determining the surface area-to-volume ratio for each nominal tank capacity:

- the tank has a smooth interior surface;
- the tank is cylindrical in shape;
- the tank is installed in a vertical position; and
- the roof or top of the tank is not in contact with drinking water.

The following equation shall be used to calculate the surface area-to-volume ratio for tanks or storage vessels of capacities that do not appear in table 5.4.

$$\text{surface area to volume ration } (in^2/L) = \frac{(36.8 \times X) + 9.2}{X^{0.66} \times Y^{0.33}}$$

where:

X = the length/diameter ratio of the tank or storage vessel
Y = the volume (in gallons) of the tank or storage vessel

5.7.2 Normalization for all other end uses

For barrier materials that have end uses other than tanks or storage vessels, normalization shall be performed using the following equation, or to the normalization requirements of the section of this Standard which addresses the specific end use of the barrier material.

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$$NF = N1 \times N2$$

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}}$$

$$N2 = \frac{V_{F(static)}}{V_{F(flowing)}}$$

where:

SA_F = surface area exposed in the field;

SA_L = surface area exposed in the laboratory;

V_L = volume of extraction water used in the laboratory;

$V_{F(static)}$ = volume of water to which the product is exposed under static conditions; and

$V_{F(flowing)}$ = volume of water to which the product is exposed under flowing conditions during a period of time equivalent to the laboratory test.

When the length of the exposure being normalized is other than 24 h in length, the normalized value shall be adjusted to reflect a 24-h exposure (e.g., multiply the normalized value by 24/72 when a 3-d exposure was used).

5.7.3 Over time exposure calculations

Laboratory values from each time point for which extractant water was collected (minimum of five data points required) shall be normalized as indicated in 5.7.1 or 5.7.2, depending on product end use. A decay curve of these normalized contaminant concentrations in relation to elapsed exposure time shall be plotted. A contaminant concentration at Day 90 of exposure shall be extrapolated from this data.

NOTE – Day 1 is defined as the time point at which extractant water for all contaminants is collected for analysis (5 d of elapsed time). Day 90 is defined as 90 d following this time point (95 d of elapsed time).

5.8 Evaluation of contaminant concentrations

5.8.1 Contaminants measured at a single time point

Normalized contaminant concentrations shall be no greater than their respective MALs determined in accordance with annex A.

5.8.2 Contaminants measured over time

Normalized Day 1 contaminant concentrations shall not exceed the short-term exposure level (STEL) as defined in annex A, section A.5. Extrapolated Day 90 contaminant concentrations shall not exceed their respective MALs determined in accordance with annex A.

Table 5.1 – Paint and coating system sample preparation

Number of layers in system	Layer	Panel surface area exposed for each layer
one layer	—	entire panel
two layer	primer layer	1/3
	top layer	2/3
three layer	primer layer	1/6
	intermediate layer	1/3
	top layer	1/2
four layer	primer layer	1/12
	first intermediate layer	1/6
	second intermediate layer	1/4
	top layer	1/2

NOTE – A layer is one or more coats of the same coating material

Table 5.2 – Single time point exposure sequence

Length of exposure	Elapsed time	Sample collection
24 ± 1 h	1 d	discard extractant water and refill
24 ± 1 h	2 d	discard extractant water and refill
48 ± 4 h	4 d	discard extractant water and refill
24 ± 1 h	5 d	extractant water collected for analysis at conclusion of exposure period

NOTE – Sample exposures are sequential: decant and discard extraction water, refill container, and continue exposure

Table 5.3 – Multiple time point exposure sequence

Length of exposure	Elapsed time	Sample collection
24 ± 1 h	1 d	extractant water collected for analysis
24 ± 1 h	2 d	extractant water collected for analysis
48 ± 4 h	4 d	discard extractant water and refill
24 ± 1 h	5 d	extractant water collected for analysis
6 ± 1 d	11 d	discard extractant water and refill
24 ± 1 h	12 d	extractant water collected for analysis
6 ± 1 d	18 d	discard extractant water and refill
24 ± 1 h	19 d	extractant water collected for analysis
6 ± 1 d	25 d	discard extractant water and refill
24 ± 1 h	26 d	extractant water collected for analysis
6 ± 1 d	32 d	discard extractant water and refill
24 ± 1 h	33 d	extractant water collected for analysis

NOTE – Sample exposures are sequential: decant required volume for analysis when indicated, discard any remaining extraction water, refill container, and continue exposure

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Table 5.4 – Surface area-to-volume ratios for tanks or storage vessels

Nominal capacity (gal)	Surface area (ft^2)[1]	Length/diameter ratio	Surface area-to-volume ratio (in^2/1 L)
5	5	5.0	38.5
10	8	5.0	30.6
25	14.8	5.0	22.5
50	20.5	3.0	15.6
75	26.8	3.0	13.6
100	32.5	3.0	12.4
200	51	2.9	9.7
300	66	2.7	8.4
400	78.9	2.6	7.5
500	90.4	2.5	6.9
600	101	2.3	6.4
700	110	2.2	6.0
800	118.7	2.1	5.7
900	126.5	1.9	5.4
1,000	133.6	1.8	5.1
1,500	175	1.8	4.4
2,000	212	1.8	4.0
3,000	278	1.8	3.5
4,000	337	1.8	3.2
5,000	391	1.8	3.0
6,000	441	1.8	2.8
7,000	489	1.8	2.7
8,000	535	1.8	2.5
9,000	578	1.8	2.44
10,000	620	1.8	2.4
20,000	985	1.8	1.9
30,000	1290	1.8	1.6
40,000	1563	1.8	1.5
50,000	1814	1.8	1.4
60,000	2048	1.8	1.3
70,000	2270	1.8	1.23
80,000	2481	1.8	1.2
90,000	2684	1.8	1.13
100,000	2879	1.8	1.1
200,000	4570	1.8	0.9
250,000	5303	1.8	0.8
500,000	8418	1.8	0.6
750,000	11,031	1.8	0.56
1,000,000	13,363	1.8	0.5
1,500,000	17,511	1.8	0.44
2,000,000	21,213	1.8	0.4
5,000,000	39,075	1.8	0.3
7,500,000	51,203	1.8	0.26
10,000,000	62,028	1.8	0.2

[1] Surface area calculations include the sides and bottom of the tank, but not the area of the roof.

6 Joining and sealing materials

6.1 Coverage

This section covers materials that join or seal pipes and related products (e.g., tanks), protective (barrier) materials, and mechanical devices that contact drinking water

6.2 Definitions

6.2.1 fluxes: Formulations intended to remove traces of surface oxides, promote wetting, and protect the surfaces to be soldered or brazed from oxidation during heating

6.2.2 gaskets and sealing materials: Materials used to fill a hole or joint to prevent leakage.

6.2.3 joining materials: Materials that form a bond when used to put parts together.

6.2.4 lubricant: Any substance interposed between two surfaces for the purpose of reducing the friction or wear between them.

6.3 Material and extraction testing requirements

Samples for testing shall be prepared as specified by the manufacturer's written instructions and exposed as outlined in annex B. Any contaminants extracted shall have normalized concentrations no greater than those limits specified in annex A.

6.4 Items of special significance

The manufacturer shall supply written information relative to the product's intended end uses and applications.

7 Process media

7.1 Scope

The requirements in this section apply to process media products intended for the reduction of dissolved or suspended materials present in drinking water. The products that are covered include, but are not limited to, process media used in the following processes: ion exchange, adsorption, oxidation, aeration, and filtration.

7.2 Definitions

7.2.1 adsorption: The retention of a gas, liquid, solid, or dissolved material onto the surface of a solid.

7.2.2 adsorption media: A process media material upon which a gas, liquid, solid, or dissolved material will be retained

7.2.3 aeration: The process of bringing water into contact with air in order to expedite the transfer of gas between the two phases.

7.2.4 aeration packing media: Media used in aerators to increase the surface area of the liquid being processed resulting in increased liquid to air contact and improved gas transfer

7.2.5 filtration: The process of passing a dilute liquid suspension through filter media to reduce the concentration of suspended or colloidal matter.

7.2.6 filtration media: Process media through which a liquid is passed for the purpose of filtration

7.2.7 ion exchange: A chemical process in which ions are reversibly interchanged between a liquid and a solid.

7.2.8 ion exchange resins: Process media consisting of insoluble polymers having functional groups capable of exchanging ions.

7.2.9 low-density process media: Process media such as diatomaceous earth, perlite, or other media, which have a bulk density of less than 500 g/L and are used for filtration purposes

7.2.10 oxidative media: Process media which chemically facilitates oxidation on the media surface and thereby enhances removal of ions from water

7.2.11 process media: Water insoluble material used to reduce the concentration of dissolved or suspended substances in water through such operations as ion exchange, aeration, adsorption, oxidation, and filtration

7.2.12 reductive media: Process media that chemically facilitates reduction on the media surface and thereby enhances removal of ions from water.

7.3 General requirements

7.3.1 Manufacturer use instructions

All process media products shall be accompanied by detailed manufacturer use instructions that shall also appear on the product packaging or other technical literature. For process media products that are dosed (e g , powdered activated carbon), use instructions shall include the maximum dose at which the product can be acceptably used (as determined by evaluation to the requirements of this section).

7.3.2 Product labeling

Process media product containers shall facilitate traceability to the production location and shall, at a minimum, contain the following information:

- manufacturer's name and address;
- production location identifier;
- product identification (product type and, when applicable, trade name);
- net weight;
- when applicable, mesh or sieve size;
- lot number; and
- when appropriate, special handling, storage, and use instructions.

7.3.3 Product line evaluation

When a line of products is manufactured to the same material formulation and contains identical ingredients, product evaluation shall be preferentially conducted on the product form that has the highest surface area-to-volume ratio (smallest particle size). Products of a lower surface area-to-volume ratio (larger particle size) shall be considered to have met the requirements of this section when a higher surface area-to-volume ratio product, belonging to the same line of products and having an identical use, has been demonstrated to meet the requirements of this section.

7.4 Sample requirements

A representative sample of the media shall be reduced to three test samples, each of a sufficient quantity for the extraction procedures described in 7.5. The three test samples shall be placed and stored in airtight,

moisture proof, sealed glass containers. If a glass container is inappropriate, containers made from some other inert material recommended by the manufacturer shall be used. Each container shall be clearly labeled with product name, type of sample, manufacturer name, sampling data, production location, lot number, and the name of the individual who collected the sample One sample shall be used for exposure and analysis; the remaining two samples shall be retained for re-evaluation purposes.

7.5 Extraction procedures

7.5.1 Analytical summary

An analytical summary shall be prepared for each product The analytical summary shall consist of the formulation-dependent analytes identified in accordance with 3 3 and the applicable product-specific minimum test batteries listed in table 7.1.

7.5.2 Wetting

Process media that receive conditioning shall be immersed completely (wetted) in tap water prior to conditioning and exposure. The weight of the sample to be wetted shall be at least equal to the amount of media required to perform the exposure at the specified weight-to-volume ratio (see 7.5.5 and table 7.3).

NOTE – For example, a media for which 2 L (0.53 gal) of extractant water is required to perform the selected analyses, and the media is exposed at 25 g/L, a minimum of 50 g of media is wetted.

For low-density process media, 0.5 L (0.13 gal) of the process media shall be wetted; the weight of this volume of media shall be measured and recorded prior to wetting.

Following the specified wetting period, the sample shall be completely drained and the water discarded.

7.5.2.1 Granular activated carbon

Granular activated carbon (GAC) test samples shall be wetted out for 16 ± 1 h.

7.5.2.2 Other process media products

All other process media that receive conditioning shall be wetted out for 60 ± 10 min.

7.5.3 Conditioning (backwashing)

7.5.3.1 Filtration and adsorption media

Wetted filtration or adsorption media, excluding diatomaceous earth, perlite, and powdered activated carbon (PAC) products, and other media of < 0.25 mm diameter, shall be placed in a conditioning chamber (a glass column having a minimum inner diameter of 2 in) The amount of media conditioned shall be sufficient to meet or exceed its specific weight-per-volume ratio (see table 7.2) and to generate sufficient exposure water to complete the selected analyses. Tap water shall be directed slowly upward through the conditioning system until the entire amount of media is flooded The media shall then be backwashed at a flow rate that fluidizes the media or attains sufficient transport velocities to remove extraneous particulate matter; the maximum wetted media expansion rates for various process media products are indicated in table 7.3. Filtration and adsorption media shall be subjected to the prescribed backwash for 30 ± 2 min.

7.5.3.2 Diatomaceous earth, perlite, PAC, and other process media

Diatomaceous earth, perlite, PAC, and all other process media having functions other than filtration or adsorption shall not be conditioned unless manufacturer use instructions stipulate a specific conditioning protocol.

7.5.3.3 Special post-conditioning procedures for sand and anthracite products

Upon completion of the backwash, 1% to 1.5% of the sand or anthracite column (by height) shall be scraped away and discarded.

7.5.4 Exposure water

7.5.4.1 Adsorption media

Adsorption media shall be exposed in a pH 5 sodium dihydrogen phosphate buffer, prepared by mixing 0.1 M NaH_2PO_4, 0.04 M $MgCl_2$, and reagent water, meeting the requirements of annex B, section B.9.2.1, at a ratio of 1:1:18, respectively.

7.5.4.2 All other process media

All other process media shall be exposed in reagent water, meeting the requirements of annex B, section B 9.2.1

7.5.5 Exposure protocols

Table 7.3 contains the weight-per-volume ratios for exposure of process media.

7.5.5.1 Adsorption media

7.5.5.1.1 Media of < 0.25 mm in diameter

Immediately after completion of wetting, the media sample shall be exposed in an appropriately sized vessel. The amount of media exposed per volume of exposure water (see 7.5.4.1) shall be sufficient to meet or exceed its specific weight-per-volume ratio in table 7.2 and to generate sufficient exposure water to complete the selected analyses. The vessel shall be covered and placed on a magnetic stirrer for 60 ± 5 min. Immediately following the exposure period, the liquid portion of the exposure shall be passed through a Whatman # 41 filter and a 0.45 μ filter, and the resulting filtrate shall be collected. The solid portion of the exposed sample remaining on the filter shall be dried and weighed and shall be used to calculate the evaluation dose.

7.5.5.1.2 Media of ≥ 0.25 mm in diameter

Immediately after completion of conditioning, the media sample shall be exposed in an appropriately sized vessel. The amount of media exposed per volume of exposure water (see 7.5.4.1) shall be sufficient to meet or exceed its specific weight-per-volume ratio in table 7.2 and to generate sufficient exposure water to complete the selected analyses. The contents of the vessel shall be mixed to ensure that the entire sample is in contact with the exposure water. The vessel shall be sealed with PTFE, and the sample shall be exposed according to the schedule outlined in table 7 4 The weight-to-volume ratio shall be recorded at the time of exposure and shall represent the evaluation dose

7.5.5.2 Filtration media, ion exchange resins, synthetic media, and all other process media

Immediately after completion of wetting, or conditioning if applicable, the media sample shall be exposed in an appropriately sized vessel. The amount of media exposed per volume of exposure water (see 7.5.4.2) shall be sufficient to meet or exceed its specific weight-per-volume ratio in table 7.2 and to generate sufficient exposure water to complete the selected analyses The contents of the vessel shall be mixed to ensure that the entire sample is in contact with the exposure water The vessel shall be sealed with PTFE, and the sample shall be exposed according to the schedule outlined in table 7 4 The weight-to-volume ratio shall be recorded at the time of exposure and shall represent the evaluation dose

7.5.5.3 Aeration packing media

Aeration packing media shall be exposed in appropriately sized vessels at a surface area-to-volume ratio greater than or equal to its manufacturer's recommended field surface area-to-volume ratio and in a volume of exposure water sufficient to complete the selected analyses The vessel shall be sealed with PTFE, and the sample shall be exposed according to the schedule outlined in table 7.4.

NOTE – The volume of extraction water can be proportionately increased if an additional amount of media was prepared in order to complete the selected analyses

7.5.6 Collection and preservation of extraction water

Immediately following exposure, extraction waters shall be poured into previously prepared sample containers for storage until analysis, as specified in annex B, section B.6.

7.6 Analysis

Extraction waters shall be analyzed with the methods listed in annex B, section B.7.

7.7 Normalization

The concentration of analytes present in the extraction water shall be multiplied by calculated normalization factors to account for differences between the actual laboratory evaluation ratio and the weight-per-volume ratio in table 7.2.

7.7.1 Process media except for activated carbon media and aeration packing media

The concentration reported by the laboratory shall be normalized with the following equation:

$$\text{normalized contaminant concentration} = \text{laboratory contaminant concentration} \times \frac{\text{weight per volume ration (mg/L)}}{\text{laboratory evaluation ratio (mg/L)}}$$

This equation shall be used to normalize filtration media, ion exchange resins, synthetic media, and other media to the weight-per-volume ratios listed in table 7.2.

7.7.2 Activated carbon media

The concentration reported by the laboratory shall be normalized with the following equation:

$$\text{normalized contaminant concentration} = \text{laboratory contaminant concentration} \times \frac{\text{250 mg/L}}{\text{laboratory evaluation ratio (mg/L)}}$$

Equation 2 shall be used to normalize activated carbon media (granular or powdered) to a weight-per-volume ratio of 250 mg/L.

7.7.3 Filter precoat media (e.g., perlite, diatomaceous earth)

The concentration reported by the laboratory shall be normalized with the following equation:

$$\text{normalized contaminant concentration} = \text{laboratory contaminant concentration} \times \frac{\text{manufacturer's use concentration (mg/L)}}{\text{laboratory evaluation ratio (mg/L)}}$$

Equation 3 shall be used to normalize dosed media (except PAC) to the manufacturer's recommended maximum use concentration

7.7.4 Aeration packing media

The concentration reported by the laboratory shall be normalized with the following equation:

$$\text{normalized contaminant concentration} = \text{laboratory contaminant concentration} \times \frac{SA_F}{SA_L} \times \frac{V_F}{V_{F(flowing)}}$$

where:

SA_L = surface area attained during laboratory exposures,

V_L = volume of exposure water used during laboratory exposures;

SA_F = surface area of the product under field conditions, and

$V_{F(flowing)}$ = minimum volume of water the product is exposed to in the field under flowing conditions during a period of time equivalent to the laboratory evaluation

NOTE – When manufacturer use instructions indicate that the aeration product can be subjected to static conditions in the field, normalized concentrations shall be modified to reflect the static condition. For the static condition, the $V_{F(flowing)}$ parameter shall be substituted with $V_{F(static)}$, which is equal to the volume of water contacting the media under static conditions in the field.

7.8 Evaluation of contaminant concentrations

7.8.1 For process media, normalized contaminant concentrations shall be no greater than their respective SPACs, determined in accordance with annex A.

7.8.2 For aeration packing media which require evaluation to the static condition, the normalized static contaminant concentrations shall be no greater than their respective MCLs or TACs determined in accordance with annex A

Table 7.1 – Product-specific minimum test batteries for process media products

Product	Primary use	Analytes
activated alumina	adsorption	metals[1], nickel, and aluminum
aluminum silicates (e.g., zeolites)	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
anthracite	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
diatomaceous earth media	filtration	metals[1] and radionuclides
garnet	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
granular activated carbon (GAC)	adsorption	metals[1], GC/MS (base neutral acid scans), and radionuclides
gravel	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
ilmenite	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
ion exchange resins	ion exchange	residual monomer, other formulation dependent
oxidative media (e.g., manganese green sand)	oxidation	metals[1], GC/MS (base neutral acid scans), and radionuclides
perlite	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
powdered activated carbon (PAC)	adsorption	metals[1], GC/MS (base neutral acid scans), and radionuclides
sand	filtration	metals[1], GC/MS (base neutral acid scans), and radionuclides
synthetic media	aeration, filtration	formulation dependent

[1] Metals = antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, thallium

Table 7.2 – Process media exposure weight-per-volume ratios

Media type	Weight-per-volume[1]
adsorption media: activated alumina GAC and PAC	 625 ± 25 g/L 25 ± 5 g/L
anthracite and gravel[2]: ≤ 3/8" diameter particles > 3/8" diameter particles	 625 ± 25 g/L 1250 ± 25 g/L
filter precoat media (e.g, perlite, diatomaceous earth)	10 times the manufacturer's recommended use concentration
filtration media other than anthracite or gravel	625 ± 25 g/L
ion exchange resins	625 ± 25 g/L
synthetic media	625 ± 25 g/L

[1] Weight-per-volume of the product on an "as shipped" basis

[2] For the size range specified, not more than 8% by weight shall be either finer than or coarser than the designated size limit (AWWA B100-96)

Table 7.3 – Maximum conditioning expansion rates for filtration and adsorption media

Media type	Maximum laboratory expansion rate of wetted media (by height) (%)
activated alumina	25 ± 5%
aluminum silicates (zeolites)	25 ± 5%
anthracite	25 ± 5%
garnet	30 ± 5%
granular activated carbon	30 ± 5%
gravel	10 ± 5%
ilmenite	30 ± 5%
manganese greensand	30 ± 5%
sands	20 ± 5%

Table 7.4 – Exposure schedule for process media of ≥ 0.25 mm in diameter

Time	Temperature	Comment
60 ± 5 min	23 ± 1 °C (73 ± 2 °F)	Exposure water is drained/decanted and discarded; the exposure vessel is refilled and exposure is continued.
60 ± 5 min	23 ± 1 °C (73 ± 2 °F)	Exposure water is drained/decanted and discarded; the exposure vessel is refilled and exposure is continued.
60 ± 5 min	23 ± 1 °C (73 ± 2 °F)	Exposure water is collected and filtered for analyses.

8 Mechanical devices

8.1 Coverage

This section covers devices, components, and materials used therein which are used in treatment/transmission/distribution systems, and are in contact with drinking water intended for human ingestion, drinking water treatment chemicals, or both Examples are listed in table 8 1 Residential point-of-use and point-of-entry drinking water treatment devices and fire hydrants are not covered by the requirements in this section

8.2 Definitions

8.2.1 in-line device: Any device (used to measure or control the flow of water) installed on a service line or building distribution system downstream of the water main and before endpoint devices.

8.2.2 building distribution system: A continuous system of piping and related fittings, beginning at-the-tap on the main, which is intended to convey potable water to points of usage.

8.3 Device, component, or material requirements

8.3.1 General

Devices, components, or materials shall be considered to have met the requirements of this section if at least one of the following conditions is met:

- the devices, components, or materials covered under this section are tested and evaluated according to the procedures specified in annex B, sections B.4 and B.8; or
- the devices, components, or materials meet the requirements of 8.3 2

Where all components, materials, or both of a device meet the requirements of this section, the device shall also meet the requirements of this section. Where all materials of a component meet the requirements of this section, the component shall also meet the requirements of this section.

8.3.2 Evaluation of devices, components, or materials tested to other sections of this Standard

For devices, components, or materials that have been tested to other sections of the Standard, the devices, components, or materials shall meet the following criteria:

- be made of the same alloy(s), composition(s), or formula(s);
- have undergone analogous manufacturing processes;
- have been tested at a temperature that meets or exceeds the required exposure temperature in annex B, section B 4;
- have been conditioned for a period of time not more than 14 d, and exposed for a period of time not less than 12 h for in-line devices or 24 h for other mechanical devices; and
- the concentration(s) of the extracted contaminant(s) shall be normalized to the requirements of annex B, section B.8

8.3.3 Metallic contaminants

When a device or component is qualified through the separate testing of two or more components, the normalized concentrations for each specific metallic contaminant from individual components shall be summed. The total of the normalized metallic contaminant concentrations shall meet the requirements of annex B, section B.8

8.4 In-line devices, components, and materials

Samples for the testing of in-line devices, components, and materials (see 8.2.1) shall be selected according to the requirements of annex B, sections B.2.3 and B.4.1. Extraction waters shall be selected according to annex B, section B.2 5. In-line product samples shall be conditioned as indicated in annex B, section B.4.3. Following conditioning, the samples shall be exposed as indicated in annex B, section B.4.4.1 and table B7. Normalization shall be as specified in annex B, sections B.8.3 and B.8.4, as applicable.

8.5 Chemical feeders and generators

Samples for the testing of chemical feeders and generators shall be selected according to the requirements of annex B, sections B 2.3 and B 4 1. Chemical feeder and generator samples shall be conditioned as indicated in annex B, section B 4 3. Following conditioning, the samples shall be exposed as indicated in annex B, section B.4.4.2. Normalization shall be as specified in annex B, section B.8.5.

8.6 Other mechanical devices, components, and materials

Samples for the testing of all other mechanical devices, components, and materials shall be selected according to the requirements of annex B, sections B.2.3 and B.4.1. Extraction waters shall be selected according to annex B, section B.2.5. Other mechanical product samples shall be conditioned as indicated in annex B, section B 4.3. Following conditioning, the samples shall be exposed as indicated in annex B, section B.4 4.3 and table B8. Normalization shall be as specified in annex B, sections B.8.3, B.8.4, and B 8 6, as applicable

Table 8.1 – Examples of mechanical devices

This table is a generic listing of the types of devices covered in this section of the Standard. This table is not intended to be a complete list of all types of mechanical devices. Inclusion of a product does not indicate either a use endorsement of the product or an automatic acceptance under the provisions of this Standard.

<table>
<tr><td>chemical feeders
– dry feeders (e g , pellet droppers)</td><td rowspan="2">switches and sensors
(e.g., water level, pressure, temperature, pH)</td></tr>
<tr><td>pressure gas injection systems pumps</td></tr>
<tr><td>vacuum injection systems</td><td>valves and related fittings
(transmission/distribution system)</td></tr>
<tr><td>disinfection/generators

– chlorine dioxide
– hypochlorite
– ozone
– ultraviolet</td><td rowspan="3">treatment devices used in water treatment facilities (excludes residential point-of-use and point-of-entry devices)

– aeration technologies
– clarifiers
– electrodialysis technologies
– microfiltration technologies
– mixers
– reverse osmosis technologies
– screens
– strainers
– ultrafiltration technologies</td></tr>
<tr><td>electrical wire
(e.g., submersible well pump wire)</td></tr>
<tr><td>pumps</td></tr>
<tr><td colspan="2">in-line devices - building distribution system
– backflow preventers
– building valves
– check valves
– compression fittings
– corporation stops
– curb stops
– expansion tanks
– meter couplings
– meter stops
– pressure regulators
– pressure tanks
– service saddles
– strainers
– valves and fittings
– water meters</td></tr>
<tr><td colspan="2">in-line devices specifically excluded
– boiler feed valves
– drilling and tapping machines
– temperature and pressure relief valves
– valves with hose thread outlets
– water meter test benches</td></tr>
</table>

9 Mechanical plumbing devices

9.1 Coverage

This section covers mechanical plumbing devices, components, and materials that are typically installed within the last liter of the distribution system (endpoint devices) and are intended to dispense water for human ingestion In-line devices are excluded from this section. Point-of-use and point-of-entry water treatment devices are excluded

9.1.1 Endpoint devices specifically included in the coverage of this section are:

- single-handle and two-handle lavatory faucets (for example: centersets, widespread, mini-spread, and basin cocks), except as exempted in 9.1.2,
- two-hole and single-hole bar faucets;
- single-handle and two-handle kitchen faucets (for example: top mounts, concealed fittings, and wall mounts);
- hot and cold water dispensers;
- drinking fountains, drinking fountain bubblers, and water coolers;
- glass fillers;
- residential refrigerator ice makers;
- supply stops and endpoint control valves; and
- commercial kitchen devices (see 9.2.3), limited to the following:
  - pot and kettle fillers (see 9.2.7);
  - devices with extended standpipes or risers (see 9.2.5); and
  - pre-rinse assemblies which include an auxiliary spout or other outlet.

NOTE 1 – Only the commercial kitchen devices listed above shall be evaluated using the 18.9 L (5 gal) normalization.

NOTE 2 – The base device to which the pre-rinse component is added shall be considered a commercial kitchen device only if it meets the definition of either a pot and kettle filler (see 9.2.7) or a device with extended standpipes or risers (see 9.2.5).

9.1.2 Endpoint devices specifically exempted from the coverage of this section are:

- bath and shower valves, shower heads of all types, and Roman tub valves;
- all drains;
- backflow prevention devices;
- pre-rinse assemblies which do not include an auxiliary spout or other outlet; and
- all endpoint devices that are not specifically intended to dispense water for human consumption, including utility, laundry, laboratory, bidet, and shampoo fittings; faucets with a hose thread spout end or with a quick disconnect end, faucets that are self-closing, metering, or electronically activated; and nonlavatory hand wash stations.

9.1.3 Endpoint devices that are exempted from the scope of this section shall be permitted to be evaluated at the option of the manufacturer. With the exception of exempted pre-rinse assemblies, all exempted devices shall be evaluated using the 1 L (0.26 gal) draw. Exempted pre-rinse assemblies shall be evaluated using the 18.9 L (5 gal) draw.

9.2 Definitions

9.2.1 cold mix volume adjustment factor (CMV): The cold water volume of the device divided by the total water volume of the device.

9.2.2 cold water volume: The volume of water contained within the portion of the device that is normally contacted by cold water (from inlet to outlet) when the device is connected to hot and cold water supplies under normal operating conditions. The volume excludes the volume of water contained within the portion of the device that is normally contacted only by hot water.

9.2.3 commercial kitchen device: An endpoint device whose sole application is delivery of water for food preparation in commercial kitchens.

9.2.4 endpoint device: Any single device typically installed within the last 1 L (0.26 gal) of the water distribution system of a building.

9.2.5 extended standpipe or riser device: An endpoint device, which includes a vertical component having a minimum height of 41 cm (16 in), measured from the deck to the outlet of the endpoint device and whose sole application is delivery of water for food preparation in commercial kitchens.

9.2.6 in-line device: Any device, (used to measure or control the flow of water) installed on a service line or building distribution system downstream of the water main and upstream from endpoint devices.

9.2.7 pot and kettle filler: An endpoint device whose sole application is delivery of water to fill pots and kettles in commercial kitchens.

9.2.8 pre-rinse assembly: An endpoint device with a hose and spray whose application is water delivery for the rinsing of tableware in commercial kitchens.

9.2.9 water distribution system (building): A continuous system of piping, devices, and related fittings, beginning after the water meter and water meter setting equipment, which is intended to convey potable water in a building to points of usage.

9.3 Device, component, or material requirements

9.3.1 General

Devices, components, or materials shall be considered to have met the requirements of this section if at least one of the following conditions are met:

- The devices, components, or materials covered under this section are tested and evaluated according to procedures specified in annex B, sections B.5 and B.8; or

- The devices, components, or materials meet the requirements of 9.3.2.

Where all components, materials, or both, of a device meet the requirements of this section, the device shall also meet the requirements of this section. Where all materials of a component meet the requirements of this section, the component shall also meet the requirements of this section.

9.3.2 Evaluation of devices, components, or materials tested to other sections of this Standard

For devices, components, or materials, which have been tested to other sections of this Standard, the devices, components, or materials shall meet the following criteria:

a) be made of the same alloy(s), composition(s), or formula(s);

b) have undergone analogous manufacturing processes;

c) have been tested at a temperature that meets or exceeds the required exposure temperature in annex B, section B.5;

d) have been conditioned for a period of time not more than 19 d and exposed for a period of time not less than 16 h; and

e) shall have the concentration(s) of the extracted contaminant(s) normalized to the requirements of annex B, section B.8.

9.3.3 Metallic contaminants

When a device or component is qualified through the separate testing of two or more components, the normalized concentrations for each specific metallic contaminant from individual components shall be summed. The total of the normalized metallic contaminant concentrations shall meet the requirements of 9.5.

9.4 Exposure and normalization

Samples for testing shall be prepared and exposed, and the extractant water analyzed as required in annex B, section B.5. The number of samples tested shall be determined as outlined in annex B, section B.5.

Exposure of endpoint samples, except for hot water dispenser samples, shall be performed at 23 ± 2 °C (73 ± 4 °F).

The concentration of extracted contaminants shall be normalized to end use conditions according to the normalization procedure outlined in annex B, section B.8 for endpoint devices, components, and materials. All endpoint devices, components, or materials, other than commercial kitchen devices, shall be evaluated using the highest surface area-to-volume product as the test sample, and shall be normalized using the 1 L (0.26 gal) first draw Commercial kitchen devices shall be evaluated using the highest surface area-to-volume product as the test sample and shall be normalized using the 18.9 L (5 gal) first draw

9.5 Evaluation of normalized contaminant concentrations

9.5.1 Evaluation of lead

For endpoint devices other than commercial kitchen devices, the lead test statistic Q shall not exceed 11 µg when normalized for the 1 L (0.26 gal) first draw sample. For commercial kitchen devices, the lead test statistic Q shall not exceed 11 µg when normalized for the 18.9 L (5 gal) first draw sample.

NOTE – The limit of 11 µg for lead is based on a limit of 15 µg total lead, including lead contributed from the device interior as well as from sources other than the device, which is assumed to be 4 µg.

9.5.2 Evaluation of non-lead contaminants

For endpoint devices other than commercial kitchen devices, the normalized concentration of a nonlead contaminant shall not exceed its SPAC (calculated in accordance with annex A) when normalized for the 1 L (0.26 gal) first draw sample. For commercial kitchen devices, the normalized concentration of a nonlead contaminant shall not exceed its SPAC when normalized for the 18.9 L (5 gal) first draw sample.

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Annex A
(normative)

Toxicology review and evaluation procedures

A.1 General requirements

This annex defines the toxicological review and evaluation procedures for the evaluation of substances imparted to drinking water through contact with drinking water system components. It is intended to establish the human health risk, if any, of the substances imparted to drinking water under the anticipated use conditions of the product. Annex D (normative) and annex E (informative) of this Standard contain evaluation criteria that have been determined according to the requirements of this annex.

The following general procedure shall be used to evaluate drinking water substances under this Standard:

a) A determination shall be made as to whether a published (publicly available in printed or electronic format) and peer-reviewed quantitative risk assessment for the substance is available.

b) When a quantitative risk assessment is available, the reviewer shall determine whether the assessment is currently used in the promulgation of a drinking water regulation or published health advisory for the substance (see the requirements of annex A, section A 3):

– If the assessment is used in the promulgation of a drinking water regulation, the Single Product Allowable Concentration (SPAC) shall be derived from the regulatory value(s); or

– If the assessment is not the basis of a drinking water regulation, the assessment and its corresponding reference dose shall be reviewed for its appropriateness in evaluating the human health risk of the drinking water substance.

NOTE – When reviewing an assessment used in the promulgation of a drinking water regulation, it is recommended that the regulatory authority be contacted to verify the currency of the assessment under consideration

c) If a published and peer-reviewed quantitative risk assessment is not currently available for the substance, the Total Allowable Concentration (TAC) and SPAC shall be derived after review of the available toxicology data for the substance (see annex A, section A.4).

– When the data requirements for qualitative risk assessment are satisfied (see annex A, section A 4.2 and table A1), a qualitative risk assessment shall be performed according to annex A, section A.7; or

– When the data requirements for quantitative risk assessment are satisfied (see annex A, section A 4 3 and table A2), a quantitative risk assessment shall be performed according to annex A, section A.7.

Figure A1, annex A, provides an overview of the toxicity data review requirements of this annex.

A.2 Definitions

A.2.1 benchmark dose: The lower 95% confidence limit on the dose that would be expected to produce a specified response in X% of a test population This dose may be expressed as BMD_X (adapted from Barnes et al., 1995).

NOTE – For the purposes of this Standard, the benchmark dose shall be calculated at the 10% response level

A.2.2 continuous data: A measurement of effect that is expressed on a continuous scale e.g., body weight or serum enzyme levels (USEPA, 1995).

A.2.3 critical effect: The first adverse effect, or its known precursor, that occurs as the dose rate increases (USEPA, 1994).

A.2.4 ED_{10}: Effective dose 10; a dose estimated to cause a 10% response in a test population (USEPA, 1996a).

A.2.5 genetic toxicity: Direct interaction with DNA that has the potential to cause heritable changes to the cell.

A.2.6 health hazards (types of) (USEPA, 1994 and 1999)

A.2.6.1 acute toxicity: Effects that occur immediately or develop rapidly after a single administration of a substance. Acute toxicity may also be referred to as immediate toxicity.

A.2.6.2 allergic reaction: Adverse reaction to a chemical resulting from previous sensitization to that chemical or to a structurally similar one.

A.2.6.3 chronic effect: An effect that occurs as a result of repeated or long-term (chronic) exposures

A.2.6.4 chronic exposure: Multiple exposures occurring over an extended period of time or a significant fraction of the animal's or the individual's lifetime.

A.2.6.5 chronic toxicity: The capability of a substance to cause adverse human health effects as a result of chronic exposure

A.2.6.6 irreversible toxicity: Toxic effects to a tissue that cannot be repaired

A.2.6.7 local toxicity: Effects that occur at the site of first contact between the biological system and the toxicant

A.2.6.8 reversible toxicity: Toxic effects that can be repaired, usually by a specific tissue's ability to regenerate or mend itself after chemical exposure.

A.2.6.9 systemic toxicity: Effects that are elicited after absorption and distribution of a toxicant from its entry point to its target tissue

A.2.7 LED_{10}: Lowest effective dose 10; the lower 95% confidence limit on a dose estimated to cause a 10% response in a test population (USEPA, 1996a)

A.2.8 lowest observed adverse effect level (LOAEL): The lowest exposure concentration at which statistically or biologically significant increases in frequency or severity of effects are observed between the exposed population and its appropriate control group (USEPA, 1994).

A.2.9 margin of exposure (MOE): The LED_{10} or other point of departure, such as a NOAEL, divided by the environmental dose of interest (USEPA, 1996a).

A.2.10 model: A mathematical function with parameters that can be adjusted so that the function closely describes a set of empirical data. A mathematical or mechanistic model is usually based on biological or physical mechanisms and has model parameters that have real world interpretation. Statistical or empirical models are curve-fitted to data where the math function used is selected for its numerical properties and accuracy. Extrapolation from mechanistic models (e.g., pharmacokinetic equations) usually carries higher confidence than extrapolation using empirical models (e.g., logit) (USEPA, 1994)

A.2.11 no observed adverse effect level (NOAEL): An exposure concentration at which no statistically or biologically significant increases in the frequency or severity of adverse effects are observed between an exposed population and its appropriate control. Some physiological effects may be produced at this concentration, but they are not considered as toxicologically significant or adverse or as precursors to adverse effects (USEPA, 1994)

A.2.12 non-regulated substance: A substance for which a statutory concentration limit does not exist.

A.2.13 peer review: A documented critical review of a scientific or technical work product conducted by qualified individuals or organizations who are independent of those who performed the work, but who are collectively equivalent or superior in technical expertise to those who performed the work. It includes an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and conclusions pertaining to the work product and the documentation that supports the conclusions reached in the report. Peer review is intended to ensure that the work product is technically adequate, competently performed, properly documented, and satisfies established requirements (USEPA, 1998).

A.2.14 point of departure: A data point or an estimated point that can be considered to be in the range of observation. The standard point of departure is the LED_{10}, which is the lower 95% confidence limit on a dose associated with 10% extra risk (adapted from Barnes et al., 1995).

A.2.15 qualitative risk assessment: An estimation of the risk associated with the exposure to a substance using a non-quantitative methodology

A.2.16 quantal data: A dichotomous measure of effect; each animal is scored "normal" or "affected" and the measure of effect is the proportion of scored animals that are affected (USEPA, 1995).

A.2.17 quantitative risk assessment: An estimation of the risk associated with the exposure to a substance using a methodology that employs evaluation of dose response relationships.

A.2.18 range of extrapolation: Doses that are outside of the range of empirical observation in animal studies, human studies, or both (adapted from Barnes et al., 1995).

A.2.19 range of observation: Doses that are within the range of empirical observation in animal studies, human studies, or both (adapted from Barnes et al., 1995).

A.2.20 reference dose (RfD): An estimate (with uncertainty spanning approximately an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1994).

A.2.21 regulated substance: A substance for which a quantitative human health risk assessment has been performed and utilized in promulgation of a statutory concentration limit for drinking water.

A.2.22 toxicodynamics: Variations in the inherent sensitivity of a species or individual to chemical-induced toxicity, resulting from differences in host factors that influence the toxic response of a target organ to a specified dose (TERA, 1996).

A.2.23 toxicokinetics: Variations in absorption, distribution, metabolism, and excretion of a compound that account for differences in the amount of parent compound or active metabolite(s) available to a target organ (TERA, 1996).

A.2.24 treatment technique: A technology or one or more procedures used to control the concentration of a substance in a drinking water supply when it is neither technically nor economically feasible to ascertain the concentration of the substance (U.S. Safe Drinking Water Act, 1996)

A.2.25 weight-of-evidence: The extent to which the available biomedical data support the hypothesis that a substance causes cancer or other toxic effects in humans (adapted from USEPA, 1994).

A.3 Data requirements for published risk assessments

A.3.1 General requirements

Evaluation of all published risk assessments shall include review of the written risk assessment document and a determination of whether additional toxicity data exist that were not considered in the assessment. If additional toxicity data are identified that were not considered in the risk assessment, the risk assessment shall be updated in accordance with annex A, section A.4.

The following shall be documented when utilizing an existing risk assessment:

- the source of the risk assessment;
- identification and discussion of any data not addressed by the assessment; and
- comparison and contrast of the existing risk assessment to the requirements of annex A, section A.4, with respect to selection of uncertainty factors or other assumptions.

A.3.2 Substances regulated by USEPA or Health Canada

If a substance is regulated under the USEPA's National Primary Drinking Water Regulations and EPA has finalized a Maximum Contaminant Level (MCL) or other means of regulation such as a treatment technique (see annex A, section A.2.24), no additional collection of toxicological data shall be required prior to performance of the risk estimation (see annex A, section A.6.1). Where Health Canada has finalized a Maximum Allowable Concentration (MAC), no additional toxicological evaluation shall be required prior to performance of the risk estimation (see annex A, section A.6.1). Annex D contains a list of regulatory values (MCL or MAC) and their corresponding SPACs. This list includes consensus evaluation criteria for those substances that are regulated by both countries.

A.3.3 Substances regulated by other agencies

If a substance is regulated by agencies including the U.S. Food and Drug Administration (Code of Federal Regulations, Title 21 Food and Drug Regulations), or state, national, or international regulatory bodies other than those specified in annex A, section A.3.2, the relevance of the regulation to drinking water shall be evaluated. This evaluation shall include a review of the quantitative risk assessment that supports the regulation, and a determination of whether additional toxicity data exist that have not been considered in the current assessment. No additional collection of toxicological data shall be required when the regulation provides sufficient information for performance of the risk estimation (see annex A, section A.6.1). If additional toxicity data are identified that were not considered in the current risk assessment, a revised risk assessment incorporating those data shall be performed as indicated in annex A, sections A.4 and A.7.

A.3.4 Evaluation of multiple published risk assessments

When multiple published assessments are available for a specific substance, the available assessments shall be reviewed and a rationale shall be provided for the selection of the assessment considered to be the most appropriate for the evaluation of human exposure through drinking water. Factors used to determine the appropriate assessment shall include, but not be limited to, the following:

- completeness and currency of the data review of each assessment;
- technical competence of the organization(s) that sponsored the assessment; and
- species and route(s) of exposure for which the assessment was performed

When multiple published risk assessments are reviewed and are determined to be of equivalent quality, the following hierarchy shall be used to select the appropriate assessment, based on sponsoring organization:

- USEPA;
- Health Canada;
- international bodies such as the World Health Organization (WHO) or the International Programme on Chemical Safety (IPCS),
- European bodies such as the Drinking Water Inspectorate (DWI) and KIWA; or
- entities such as other federal or state regulatory agencies, private corporations, industry associations, or individuals.

A.4 Data requirements for new or updated risk assessments

A.4.1 General requirements

For each substance requiring a new or updated risk assessment, toxicity data to be considered shall include, but not be limited to, assays of genetic toxicity, acute toxicity (1- to 14-d exposure), short-term toxicity (14- to 28-d exposure), subchronic toxicity (90-d exposure), reproductive toxicity, developmental toxicity, immunotoxicity, neurotoxicity, chronic toxicity (including carcinogenicity), and human data (clinical, epidemiological, or occupational) when available. To more fully understand the toxic potential of the substance, supplemental studies shall be reviewed, including, but not limited to, mode or mechanism of action, pharmacokinetics, pharmacodynamics, sensitization, endocrine disruption, and other endpoints, as well as studies using routes of exposure other than ingestion. Structure activity relationships, physical and chemical properties, and any other chemical specific information relevant to the risk assessment shall also be reviewed.

Toxicity testing shall be performed in accordance with the most recent adopted toxicity testing protocols such as those described by the Organization For Economic Cooperation and Development (OECD), U S Environmental Protection Agency (USEPA), and U.S. Food and Drug Administration (FDA) All studies shall be reviewed for compliance with Good Laboratory Practice (21 CFR, Pt 58/40 CFR, Pt 792).

NOTE – Review of the study according to the approach suggested in Klimisch et al, 1997 may also be used to determine the quality of reported data.

A weight-of-evidence approach shall be employed in evaluating the results of the available toxicity data. This approach shall include considering the likelihood of hazard to human health and the conditions under which such hazard may be expressed. A characterization of the expression of such effects shall also be included, as well as the consideration of the substance's apparent mode of action. The quality and quantity of toxicity data available for the substance shall determine whether the evaluation is performed using a qualitative risk assessment approach (see annex A, section A.4.2) or a quantitative risk assessment approach (see annex A, section A.4.3).

A.4.2 Data requirements for qualitative risk assessment

Toxicity testing requirements for the qualitative risk assessment procedure are defined in annex A, table A1. A minimum data set consisting of a gene mutation assay and a chromosomal aberration assay shall be required for the performance of a qualitative risk assessment. Modifications in the specified toxicity testing requirements (inclusions or exclusions) shall be permitted when well supported by peer-reviewed scientific judgment and rationale.

NOTE – Modifications may include, but are not limited to, the following types of considerations: alternate assays of genetic toxicity, and supplemental toxicity studies other than those specified.

Required studies and available supplemental studies shall be reviewed in order to perform a qualitative risk estimation in accordance with annex A, section A.7.2.

A.4.3 Data requirements for quantitative risk assessment

Toxicity testing requirements for the quantitative risk assessment procedure are defined in annex A, table A2. A minimum data set consisting of a gene mutation assay, a chromosomal aberration assay, and a subchronic toxicity study shall be required for the performance of a quantitative risk assessment. The required studies and preferred criteria are defined in annex A, table A2. Modifications to the minimum data set shall be permitted when well supported by peer-reviewed scientific judgment and rationale.

NOTE – Modifications may include, but are not limited to, acceptance of studies using alternate routes of exposure, alternate assays of genetic toxicity, and supplemental toxicity studies other than those specified.

Required studies, additional studies, and available supplemental studies shall be reviewed in order to perform a quantitative risk estimation in accordance with annex A, section A.7.3.

Additional studies for the evaluation of reproductive and developmental toxicity (as specified in annex A, table A2) shall be required to be reviewed when:

- results of the required minimum data set studies and any supplemental studies indicate toxicity to the reproductive or endocrine tissues of one or both sexes of experimental animals; or

- the compound under evaluation is closely related to a known reproductive or developmental toxicant.

A.5 Data requirements for evaluating short-term exposures

Extractants from products used in contact with drinking water may be elevated initially but rapidly decline with continued product contact with water Examples include, but are not limited to, solvent-containing coatings and solvent cements. Short-term exposure paradigms, appropriate for potentially high initial substance concentrations, shall be used to evaluate potential acute risk to human health of short-term exposures. The short-term exposure period shall be defined as the first 14 d of in-service life of the product.

Sound scientific judgment shall be used to determine whether calculation of a Short-Term Exposure Level (STEL) is appropriate for a given contaminant The NOAEL or LOAEL for the critical short-term hazard of the substance shall be identified The following types of studies shall be considered for identification of short-term hazard:

- short-term (less than 90 d duration) toxicity study in rodents or other appropriate species with a minimum 14-d post-treatment observation period, clinical observations, hematology and clinical chemistry, and gross pathology (preferably an oral study in rodents);

- reproduction or developmental assays (for substances having these endpoints as the critical effects); or

- subchronic 90-d study in rodents or other species (preferably an oral study in rats)

The critical study shall be used to calculate a Short-Term Exposure Level (STEL) in accordance with annex A, section A.8.

Selection of uncertainty factors for calculation of a STEL shall consider the quality and completeness of the database for assessing potential short-effects Selection of uncertainty factors shall also consider data that

quantify interspecies and intraspecies variations. Other parameters that shall be considered in the determination of a STEL include identification of any sensitive subpopulations, the potential for adverse taste and odor, and solubility limitations at the calculated STEL. The STEL shall be calculated using assumptions to protect for a child's exposure to the contaminant in the absence of data that demonstrate adults are more sensitive than children In the absence of appropriate data to calculate a STEL, see annex A, section A 7 1.2.

A.6 Risk estimation for published assessments

Calculation of the SPAC is intended to account for the potential contribution of a single substance by multiple products or materials in the drinking water treatment and distribution system. In any given drinking water treatment and distribution system, a variety of products and materials may be added to or contact the treated water prior to ingestion The SPAC calculation is intended to ensure that the total contribution of a single substance from all potential sources in the drinking water treatment and distribution system does not exceed its acceptable concentration

A.6.1 SPAC calculation for regulated substances

To calculate the SPAC, an estimate of the number of potential sources of the substance from all products in the drinking water treatment and distribution system shall be determined. The SPAC shall be calculated as follows:

$$\text{SPAC (mg/L)} = \frac{\text{promulgated regulatory value (mg/L)}}{\text{estimated number of drinking water sources}}$$

In the absence of specific data regarding the number of potential sources of the substance in the drinking water treatment and distribution system, the SPAC shall be calculated as 10% of the promulgated regulatory value.

A.6.2 SPAC calculation for other published risk assessments

Review of the risk assessment shall include evaluation of the risk estimation, if one is provided. If the existing risk estimation has been performed in a manner consistent with the procedures in annex A, section A.7 3 for non-carcinogenic or carcinogenic endpoints, the SPAC shall be calculated as follows:

$$\text{SPAC (mg/L)} = \frac{\text{estimated risk estimation (mg/L)}}{\text{estimated number of drinking water sources}}$$

In the absence of specific data regarding the number of potential sources of the substance in the drinking water treatment and distribution system, the SPAC shall be calculated as 10% of the existing risk estimation.

If the existing risk estimation is not consistent with annex A, section A.7.3, or a risk estimation is not provided, a TAC and SPAC shall be calculated for the substance according to the procedures in annex A, section A 7.3

A.7 Risk estimation using new and updated risk assessments

The method of risk estimation used for new and updated risk assessments shall be determined by the quantity and quality of toxicity data identified for the contaminant of concern (see annex A, section A.4). When available toxicity data are insufficient to perform the qualitative or quantitative risk assessments, or when toxicity data are available, but the normalized contaminant concentration does not exceed the applicable threshold of evaluation value, a threshold of evaluation shall be determined for the substance according to annex A, section A.7.1 if applicable. For all other data sets, the risk estimation shall be performed according to annex A, sections A.7.2 or A.7.3

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A.7.1 Threshold of evaluation

The following thresholds of evaluation shall be considered when available toxicity data do not meet the minimum requirements to perform a risk estimation using either the qualitative or quantitative approaches Application of the threshold of evaluation shall also be considered for the evaluation of normalized contaminant concentrations that do not have existing risk assessments and that do not exceed the defined threshold of evaluation concentrations. In this case, a qualitative review of the available data shall be performed to determine whether adverse health effects can result at the threshold of evaluation exposure concentrations defined in annex A, section A.7.1.1.

A.7.1.1 Threshold of evaluation for chronic exposure

Performance of a risk assessment shall not be required for an individual substance having a normalized concentration less than or equal to the following threshold of evaluation values:

- static normalization conditions:

  toxicity testing shall not be required for an individual substance having a normalized concentration less than or equal to the threshold of evaluation value of 3 µg/L

- flowing normalization conditions:

  toxicity testing shall not be required for an individual substance having a normalized concentration less than or equal to the threshold of evaluation value of 0.3 µg/L.

These threshold of evaluation values shall not apply to any substance for which available toxicity data and sound scientific judgement such as structure activity relationships indicate that an adverse health effect results at these exposure concentrations.

A.7.1.2 Threshold of evaluation for short-term exposure

If an appropriate short-term toxic effect is not identified by the available data, the initial (Day 1) laboratory concentration shall not exceed 10 µg/L This threshold of evaluation value shall not apply to any chemical for which available toxicity data and sound scientific judgment such as structure activity relationships indicate that an adverse health effect can result at the 10 µg/L concentration upon short-term exposure to the chemical.

A.7.2 TAC determination for qualitative risk assessment

TACs for qualitative risk assessments shall be determined as indicated in annex A, table A3.

A.7.3 TAC calculation for quantitative risk assessment

The procedure used to calculate the TAC for a new risk assessment (including qualitative assessments that are updated upon generation of new data) shall be determined by the toxicologic endpoint identified as the critical effect (see annex A, section A 2.3) For a substance having a non-carcinogenic endpoint, a TAC shall be calculated according to annex A, section A.7.3.1. For a substance having carcinogenic potential, a TAC shall be calculated according to annex A, section A.7.3.2.

The minimum data set for the quantitative risk assessment (as defined in annex A, section A.4.3 and table A2) shall first be evaluated for genotoxic potential according to the requirements of annex A, table A3. Based on the review of genotoxic potential, the need for supplemental studies or chronic toxicity and carcinogenesis data shall be determined

A.7.3.1 Assessment of noncarcinogenic endpoints

For noncarcinogenic endpoints, the TAC shall be calculated using either the NOAEL/LOAEL procedure outlined in annex A, section A.7.3.1.1, or the benchmark dose (BMD) procedure outlined in annex A, section A.7.3.1.2, as appropriate. The rationale for the selection of the procedure shall be provided in the assessment.

NOTE – Selection of the appropriate TAC calculation procedure will depend on the characteristics of the data set identified for the substance. Simple data sets consisting of a small number of studies may be best evaluated using the procedure in annex A, section A.7.3.1.1. Complex data sets consisting of several studies, or which involve reproduction or developmental endpoints, may be best evaluated using the benchmark dose procedure in annex A, section A.7.3.1.2. The appropriateness of the fit of the data to the BMD shall also be considered.

A.7.3.1.1 NOAEL or LOAEL approach

The substance data set shall be reviewed in its entirety, and the highest NOAEL for the most appropriate test species, relevant route of exposure, study duration, mechanism, tissue response, and toxicological endpoint shall be identified. If a NOAEL cannot be clearly defined from the data, the lowest LOAEL for the most appropriate test species, relevant route of exposure, and toxicological endpoint shall be utilized.

The general procedure for calculating the TAC using this approach is as follows:

a) Determine the critical study and effect from which the NOAEL or LOAEL will be identified according to the following hierarchy (USEPA, 1993 and Dourson et al., 1994):

- adequate studies in humans,
- adequate studies in animal models most biologically relevant to humans (e.g., primates), or that demonstrate similar pharmacokinetics to humans;
- adequate studies in the most sensitive animal species (the species showing an adverse effect at the lowest administered dose using an appropriate vehicle, an adequate study duration, and a relevant route of exposure), and
- effects that are biologically relevant to humans.

b) calculate the reference dose (RfD) according to the following equation (based on USEPA, 1993):

$$\underset{\text{(mg/kg/day)}}{\text{RfD}} \times \frac{\text{NOAEL or LOAEL (mg/kg/day)}}{\text{UF}} \times \frac{\text{number of days dosed per week}}{\text{7 days}}$$

NOTE – When other than daily dosing was used in the critical study, the RfD calculation shall be adjusted to reflect a daily dosing schedule.

c) calculate the TAC based on the RfD with adjustment for significant contribution(s) of the substance from sources other than drinking water according to the following equation:

$$\text{TAC (mg/L)} = \frac{[\text{RfD (mg/kg/day)} \times \text{BW (kg)}] - [\text{total contribution of other sources (mg/day)}]}{\text{DWI (L/day)}}$$

where:

NOAEL = Highest NOAEL for the critical effect in the most appropriate species identified after review of data set. If a NOAEL is not defined, the LOAEL shall be used with a corresponding adjustment in the uncertainty factor (see annex A, table A4);

BW = Assumed body weight of individual to be protected in kg (generally 10 kg for a child and 70 kg for an adult);

UF = Uncertainty factor (total) based upon the applicability of the test data in extrapolating to actual conditions of human exposure (see annex A, table A4). These are often referred to as safety factors; and

DWI = Drinking Water Intake is the assumed average daily drinking water consumption per day (generally 1 L for a child and 2 L for an adult)

NOTE 1 – In the absence of data to determine the drinking water contribution of a substance, a default drinking water contribution of 20% shall be applied (USEPA, 1991).

NOTE 2 – If calculation of the non-drinking water contribution of a substance exceeds the value of the (RfD x BW), verify that all potential exposures to the substance in the critical study have been accounted, e.g., is the substance present as a contaminant in the feed as well as dosed into the drinking water, etc

A.7.3.1.2 Benchmark dose approach

The benchmark dose level (BMDL) for the substance shall be calculated by modeling the substance's dose response curve for the critical effect in the region of observed responses The benchmark response (BMR) concentration shall be determined by whether the critical response is a continuous endpoint measurement or a quantal endpoint measurement. The BMR shall be calculated at the 10% response level

The general procedure for calculating the TAC using the BMDL is as follows:

a) calculate the reference dose (RfD) according to the following equation:

$$\text{RfD (mg/kg/day)} = \frac{\text{BMDL (mg/kg/day)}}{\text{UF}} \times \frac{\text{number of days dosed per week}}{\text{7 days}}$$

NOTE – When other than daily dosing was used in the critical study, the RfD calculation shall be adjusted to reflect a daily dosing schedule.

b) calculate the TAC based on the RfD with adjustment for significant contribution(s) of the substance from sources other than water according to the following equation:

$$\text{TAC (mg/L)} = \frac{\text{[RfD (mg/kg/day) x BW (kg)] - [total contribution of other sources (mg/day)]}}{\text{DWI (L/day)}}$$

where:

BMDL = The lower confidence limit on the dose that produces a specified magnitude of change (10%) in a specified adverse response (BMD_{10});

BW = Assumed body weight of individual to be protected in kg (generally 10 kg for a child, and 70 kg for an adult);

UF = Uncertainty factor (total) based upon the applicability of the test data in extrapolating to actual conditions of human exposure (see annex A, table A4) These are often referred to as safety factors; and

DWI = Drinking Water Intake is the assumed average daily drinking water consumption per day (generally 1 L for a child and 2 L for an adult)

NOTE 1 – In the absence of data to determine the drinking water contribution of a substance, a default drinking water contribution of 20% shall be applied (USEPA, 1991).

NOTE 2 – If calculation of the non-drinking water contribution of a substance exceeds the value of the (RfD x BW), verify that all potential exposures to the substance in the critical study have been accounted, e.g., is the substance present as a contaminant in the feed as well as dosed into the drinking water, etc.

A.7.3.1.3 Selection of uncertainty factors (UFs)

Uncertainty factors used for the risk estimation shall include consideration of the areas of uncertainty listed in annex A, table A4. A default value of 10 shall be used for individual areas of uncertainty when adequate data are not available to support a data-derived uncertainty factor. Selection of the values of each uncertainty factor shall consider the following criteria (adapted from Dourson et al., 1996[1])

A.7.3.1.3.1 Human variability

Selection of the human variability factor shall be based on the availability of data that identify sensitive subpopulations of humans. If sufficient data are available to quantitate the toxicokinetic and toxicodynamic variability of humans (see annex A, sections A.2.22 and A.2.23), factor values of 3, 1, or a value determined from the data shall be considered. In the absence of these data, the default value of 10 shall be used.

A.7.3.1.3.2 Interspecies variability

Selection of the interspecies variability factor shall be based on the availability of data that allow for a quantitative extrapolation of animal dose to the equivalent human dose for effects of similar magnitude or for a NOAEL. This includes scientifically documented differences or similarities in physiology, metabolism and toxic response(s) between experimental animals and humans. If sufficient data are available to quantitate the toxicokinetic and toxicodynamic variabilities between experimental animals and humans (see annex A, sections A.2.22 and A.2.23), factor values of 3, 1, or a value determined from the data shall be considered. In the absence of these data, the default value of 10 shall be used.

A.7.3.1.3.3 Subchronic to chronic extrapolation

Selection of the factor for subchronic to chronic extrapolation shall be based on the availability of data that allow for quantitative extrapolation of the critical effect after subchronic exposure to that after chronic exposure. Selection shall also consider whether NOAELs differ quantitatively when different critical effects are observed after subchronic and chronic exposure to the compound. When the critical effect is identified from a study of chronic exposure, the factor value shall be 1. When sufficient data are available to quantitate the difference in the critical effect after subchronic and chronic exposure, or when the principal studies do not suggest that duration of exposure is a determinant of the critical effects, a factor value of 3 or a value determined from the data shall be considered. In the absence of these data, the default value of 10 shall be used.

A.7.3.1.3.4 Database sufficiency

Selection of the factor for database sufficiency shall be based on the ability of the existing data to support a scientific judgment of the likely critical effect of exposure to the compound. When data exist from a minimum of five core studies (two chronic bioassays in different species, one two-generation reproductive study, and two developmental toxicity studies in different species), a factor value of 1 shall be considered. When several,

[1] The Food Quality Protection Act (FQPA) of 1996 re-emphasized the review and evaluation of toxicity data for the protection of children's health. USEPA has been very responsive to this initiative and published a draft document outlining the use of an uncertainty factor for children's protection and other database deficiencies (USEPA, 1999). Currently this factor is applied to pesticide evaluations only. In addition, publications by Renwick (1993) and the International Programme for Chemical Safety (IPCS) (1994) suggest the use of specific data in lieu of default values for uncertainty factors. This suggestion has been actively discussed at subsequent IPCS meetings and several individual chemical examples have been published (IPCS, 1999). The use of data-derived uncertainty factors, or judgment, as replacements to default values of 10-fold for each area of uncertainty is encouraged by several federal and international agencies and organizations (Meek, 1994; and Dourson, 1994).

but not all, of the core studies are available, a factor value of 3 shall be considered. When several of the core studies are unavailable, the default value of 10 shall be used.

A.7.3.1.3.5 LOAEL to NOAEL extrapolation

Selection of the factor for LOAEL to NOAEL extrapolation shall be based on the ability of the existing data to allow the use of a LOAEL rather than a NOAEL for non-cancer risk estimation. If a well-defined NOAEL is identified, the factor value shall be 1. When the identified LOAEL is for a minimally adverse or reversible toxic effect, a factor value of 3 shall be considered. When the identified LOAEL is for a severe or irreversible toxic effect, a factor value of 10 shall be used.

A.7.3.2 Assessment of carcinogenic endpoints

Risk assessment for carcinogenic endpoints shall be performed using the linear approach, the non-linear approach, or both, consistent with the proposed USEPA Cancer Risk Assessment Guidelines (USEPA, 1996a). For substances that have been identified as known or likely human carcinogens (as defined by these Guidelines), a dose response assessment shall be performed. This dose response assessment shall include analysis of dose both in the range of observation (animal and human studies) and in the range of extrapolation to lower doses.

A.7.3.2.1 Analysis in the range of observation

Curve-fitting models shall be selected based on the characteristics of the response data in the observed range. The model shall be selected, to the extent possible, based on the biological mode of action of the substance taken together in a weight of evidence evaluation of the available toxicological and biological data. The selected model shall be used to determine the LED_{10}, which will either be the point of departure (see annex A, section A.2.14) for linear low dose extrapolation or the basis of the margin of exposure (MOE) analysis (see annex A, section A.2 9) for a non-linear assessment

NOTE – See annex A, figure A2 for a graphical representation of this analysis

The following types of models shall be considered, as appropriate to the mode of action of the substance under evaluation, the availability of adequate data, and the current state of risk assessment approaches:

- statistical or distribution models;
  - log-probit;
  - logit, or
  - Weibull.
- mechanistic models;
  - one-hit,
  - multihit;
  - multistage, or
  - cell kinetic multistage.
- model enhancement and dose scaling;
  - time to tumor response;
  - physiologically based toxicokinetic models;
  - biologically based dose-response models; or
  - surface area conversion

If none of the available models provide a reasonable fit to the dataset, the following shall be considered to see if lack of fit can be resolved (USEPA, 1995):

– interference at higher dose concentrations from competing mechanisms of toxicity that are a progressive form of the response of interest;

– saturation of metabolic or delivery systems for the ultimate toxicant at higher dose concentrations; and

– interference at higher dose concentrations due to toxic effects unrelated to the response of interest.

NOTE – When adjusting for these possibilities does not provide a reasonable fit, one suggested approach is to delete the high dose data and refit the models based on the lower dose concentrations since these doses are the most informative of the exposure concentrations anticipated to be encountered by humans

A.7.3.2.2 Analysis in the range of extrapolation

The choice of procedure for low dose extrapolation shall be based on the biological mode of action of the substance Depending upon the quantity and quality of the data, and upon the conclusion of the weight of evidence evaluation, the following procedures shall be used: linear, non-linear, or linear and non-linear

A.7.3.2.2.1 Linear analysis

The linear default assumption shall be used when the toxicological data support a mode of action due to DNA reactivity or another mode of action that is anticipated to be linear in nature. It shall also be used when no data are available to justify an alternate approach. For linear extrapolation, a straight line is constructed from the point of departure on the dose response curve to the zero dose/zero response point.

A.7.3.2.2.2 Non-linear analysis

The non-linear default assumption shall be used when the toxicological data are sufficient to support the assumption of a non-linear mechanism of action and no evidence for linearity is available. A margin of exposure (MOE) analysis shall be used for non-linear assessment. The margin of exposure shall be calculated by dividing the point of departure by the human exposure concentration of interest.

A.7.3.2.2.3 Linear and non-linear analysis

Linear and non-linear assessments shall be provided when the weight of evidence or the mode of action analysis indicates differing modes of action for different target tissues or to evaluate the implications of complex dose response relationships. Where the results of linear and non-linear evaluations differ, the range of estimates shall be discussed, along with a justification for the estimate used in evaluation of the substance

A.7.3.3 Determination of the TAC for carcinogenic endpoints

The selected model shall be used to determine the dose equivalent to the LED_{10}. For linear analyses, the TAC shall be determined by linear extrapolation of the LED_{10} to the origin of the dose response curve for the selected level of risk. For non-linear analyses, the TAC shall be equal to the human exposure concentration of interest that represents the selected MOE (LED_{10}/exposure of interest). For both types of analyses, the level of risk or margin of exposure shall be selected in accordance with the USEPA Cancer Risk Assessment Guidelines (USEPA, 1996a).

A.7.4 Single Product Allowable Concentration (SPAC) calculation for new or updated risk assessments

Calculation of the SPAC is intended to account for potential contribution of a single substance by multiple products or materials in the drinking water treatment and distribution system. In any given drinking water treatment and distribution system, a variety of products and materials may be added to or contact the treated water prior to ingestion. The SPAC calculation is intended to ensure that the total contribution of a single

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substance from all potential sources in the drinking water treatment and distribution system does not exceed its acceptable concentration

A.7.4.1 SPAC determination for qualitative risk assessment

The SPAC for qualitative risk assessments shall be equal to the value of the TAC.

A.7.4.2 SPAC determination for quantitative risk assessment

To calculate the SPAC, an estimate of the number of potential sources of the substance from all products in the drinking water treatment and distribution system shall be determined. The SPAC shall be calculated as follows:

$$\text{SPAC (mg/L)} = \frac{\text{TAC (mg/L)}}{\text{estimated number of drinking water sources}}$$

In the absence of specific data regarding the number of potential sources of the substance in the drinking water treatment and distribution system, the SPAC shall be calculated as 10% of the TAC.

A.8 Risk estimation for short-term exposure (STEL calculation)

The STEL shall be calculated using the following equation:

$$\text{STEL (mg/L)} = \frac{\text{NOAEL or LOAEL (mg/kg/day)}}{\text{UF}} \times \frac{\text{BW (kg)}}{\text{DWI (L/day)}} = \frac{\text{number of days dosed per week}}{\text{7 days}}$$

NOTE – When other than daily dosing was used in the critical study, the STEL calculation shall be adjusted to reflect the dosing schedule.
where:

NOAEL = Highest NOAEL for the critical effect in a study of less than or equal to 90 d duration (see annex A, section A.5); if a NOAEL is not defined, the LOAEL shall be used with a corresponding adjustment to the uncertainty factor (see annex A, table A4);

BW = Assumed body weight of the individual to be protected (in kg), generally 10 kg for a child and 70 kg for an adult. The default body weight shall reflect that of a child, in the absence of data that demonstrate that adults are more sensitive than children;

UF = Uncertainty factor based upon the applicability of the test data in extrapolating to actual conditions of human exposure (see annex A, table A4); also referred to as safety factors; and

DWI = Drinking Water Intake is the assumed average daily drinking water consumption in L/d, generally 1 L for a child and 2 L for an adult. The default water consumption shall reflect that of a child, in the absence of data that demonstrate that adults are more sensitive than children.

A.9 Development of chemical class-based evaluation criteria

A.9.1 Identification of the need for chemical class-based evaluation criteria

Annex A provides a threshold of evaluation to be utilized when the required toxicity data to perform qualitative or quantitative risk assessment (see annex A, section A.4) are unavailable, or when the required data are available, but the normalized contaminant concentrations do not exceed the threshold of evaluation

concentrations (see annex A, section A.7.1). However, normalized contaminant concentrations for chemicals that do not meet minimum data requirements may exceed the threshold of evaluation concentrations. In this case, it may be possible to determine chemical class-based evaluation criteria for the substance on the basis of the known toxicities of other chemicals of similar structure and functionality. Those criteria can then be used as surrogates to the TAC and SPAC established on the basis of chemical-specific information.

Class-based evaluation criteria shall not be used for any substance for which adequate data exist to perform a chemical-specific risk assessment.

A.9.2 Procedure for defining class-based evaluation criteria

A.9.2.1 Establishment of the chemical class

The chemical class for which the class-based evaluation criteria are to be established shall consist of a clearly defined and closely related group of substances, and shall be defined according to chemical structure (e.g., aliphatic, aromatic, etc.), primary chemical functional group(s) (e.g., alcohol, aldehyde, ketone, etc.), and molecular weight or weight range.

A.9.2.2 Review of chemical class toxicity information

Once the chemical class has been defined according to annex A, section A.9.2.1, information on chemicals of known toxicity that are included in the defined chemical class shall be reviewed. An appropriate number of chemicals of known toxicity shall be reviewed to establish class-based evaluation criteria. Sources of data for chemicals of known toxicity shall include, but not be limited to, the following:

- USEPA risk assessments, including Maximum Contaminant Levels (MCL), Health Advisories, and Integrated Risk Information System (IRIS) entries;
- Health Canada risk assessments;
- risk assessments previously performed to the requirements of annex A;
- state or provincial drinking water standards and guidelines; and
- World Health Organization (WHO) or other international drinking water standards and guidelines

An MCL and SPAC (regulated contaminants) or a TAC and SPAC (non-regulated contaminants) shall be identified for each chemical of known toxicity that is being used to determine the class-based evaluation criteria. Carcinogenic potential shall be evaluated using a quantitative structure-activity relationship program (e.g., OncoLogic®[2] or equivalent) to verify the carcinogenic potential of the chemical of unknown toxicity is no greater than that of the chemicals being used to define the class-based evaluation criteria.

A.9.2.3 Determination of the class-based evaluation criteria

After review of the available toxicity information specified in annex A, section A.9.2.2, the class-based evaluation criteria shall not exceed the lowest MCL or TAC and SPAC identified for the chemicals of known toxicity in the defined chemical class. These evaluation criteria shall be used as surrogates for the TAC and SPAC for each chemical of unknown toxicity that meets the specifications of the defined chemical class (see annex A, section A.9.2.1), until such time as sufficient toxicity data are available to determine chemical-specific evaluation criteria.

The class-based evaluation criteria shall not be applied to any substance for which available data and sound scientific judgment, such as structure-activity relationship considerations, indicate that adverse health effects may result at the established class-based evaluation criteria concentrations. If, after a chemical class is

[2] Logichem, Inc. P.O. Box 357 Boyertown, PA 19512

defined and its evaluation criteria established, a substance of greater toxicological significance is identified within the class, the class-based evaluation criteria shall be re-evaluated and revised to the acceptable concentrations of the new substance

NOTE – It is recommended that documentation supporting class-based evaluation criteria be subject to the external peer-review requirements of annex A, section A.10.15.

A.10 Key elements of a risk assessment for drinking water additive chemicals

This section establishes the minimum criteria for the documentation of the data review performed on each drinking water additive chemical that requires a new or updated assessment. The assessment shall include, but not be limited to, evaluation of the elements detailed in this section.

A.10.1 Abstract

A summary shall be provided of the following:

- overview of the key toxicology studies;
- rationale for the selection of the critical effect and the corresponding NOAEL or other endpoint for calculation;
- major assumptions used in the assessment and areas of uncertainty; and
- presentation of the RfD, TAC, SPAC, and STEL values.

A.10.2 Physical and chemical properties

The assessment shall define the following parameters for the substance, as applicable:

- chemical formula, structure, CAS number, and molecular weight;
- physical state and appearance;
- melting point or boiling point;
- vapor pressure;
- solubility in water;
- density;
- organoleptic properties (taste and odor thresholds);
- dissociation constant (pKa); and
- partition coefficients (octanol/water, air/water).

A.10.3 Production and use

The assessment shall review the method(s) of production of the substance, whether it is a synthetic or a naturally occurring substance, and the principal uses of the chemical. This includes any use as a water treatment chemical or a food additive (direct or indirect) and its presence in such products as medicines, personal care products, or cosmetics.

A.10.4 Analytical methods

For each identified analytical method for the substance, the following shall be summarized:

- analytical matrix;
- sample preparation, if applicable,
- method of analysis;

- type of detector or the wavelength for spectroscopic methods; and
- detection limit.

A.10.5 Sources of human and environmental exposure

The assessment shall describe the substance's natural occurrence, if any, and its presence in food or other media. Human exposure from drinking water, food, and air shall be described, including occupational exposures. The major source(s) and route(s) of human exposure shall be identified.

A.10.6 Comparative kinetics and metabolism

All references describing the absorption, distribution, metabolism, and excretion of the substance shall be reviewed. Both human data (when available) and animal data shall be included.

A.10.7 Effects on humans

A summary of each relevant reference documenting human exposure to the substance that is used in the hazard assessment shall be provided. These exposures can include both case reports of incidental human exposure to the substance and epidemiological studies that explore the association between human exposure and specific toxic endpoints. Primary literature references shall be reviewed whenever possible.

Supporting data or other studies not utilized in the hazard assessment can be summarized in tabular form.

A.10.8 Effects on laboratory animals and *in vitro* test systems

A summary of each key study of the substance in experimental animals or *in vitro* test systems that is used in the hazard assessment shall be provided. The references used shall meet established toxicity study guidelines, as defined in annex A, section A.4.1, or any deficiencies shall be clearly identified. Studies shall include, but are not limited to the following: single exposure, short-term exposure (repeated dose study of < 28 d), long-term and chronic exposure (repeated dose study of ≥ 28 d), genotoxicity, reproduction and developmental toxicity, immunotoxicity, and neurotoxicity. Primary literature references shall be reviewed whenever possible.

Supporting data or other studies not utilized in the hazard assessment can be summarized in tabular form.

A.10.9 Effects evaluation

The effects evaluation is intended to provide an overall summary of the data reviewed for the substance and describe its mode/mechanism of action, if possible. This evaluation also serves to define the level of hazard represented by exposure to the substance at relevant human concentrations. This evaluation shall contain three major elements: hazard identification (assessment), dose-response assessment, and exposure characterization.

A.10.9.1 Hazard identification

The hazard identification (assessment) shall identify and discuss the following issues:

- the key data that define the basis of the concern to human health;

- the characterization of the substance as carcinogenic or non-carcinogenic, the basis for this characterization, and the critical effect(s);

- the extent to which this characterization is a function of study design (e.g., adequate number of doses used, effects noted only at highest dose, study performed at the maximum tolerated dose);

- the conclusions of the key study(ies) and whether they are supported or conflicted by other data;

- the significant data gaps for the substance and any relevant non-positive data;

- the available human data (case reports or epidemiological studies) and how they support or do not support the conclusions from the key study(ies);

- the mechanism by which the substance produces the adverse effect(s) noted in the key study and whether this mechanism is relevant to humans; and

- the summary of the hazard assessment including confidence in the conclusions, alternate conclusions that may also be supported by the data, significant data gaps, and the major assumptions used in the assessment.

A.10.9.2 Dose-response assessment

The dose-response assessment shall identify and discuss the following issues:

- the data used to define the dose-response curve and in which species the data were generated,

- if animal data were used, whether the most sensitive species was evaluated;

- if human data were used, whether positive and negative data were reported;

- whether the critical data were from the same route of exposure as the expected human exposure (drinking water), and if not, discuss whether pharmacokinetic data are available to extrapolate between routes of exposure;

- for non-carcinogens, the methodology employed to calculate the RfD and the selection of the uncertainty factors that were used;

- for carcinogens, the dose-response model selected to calculate the LED_{10} and the rationale supporting its selection; and

- document the RfD calculation (see annex A, section A.7.3).

A.10.9.3 Exposure characterization

The exposure characterization shall identify and discuss the following issues:

- the most significant source(s) of environmental exposure to the substance and the relative source contribution of each;

- the population(s) most at risk of exposure and identify highly exposed or sensitive subpopulations; and

- any issues related to cumulative or multiple exposures to the substance.

A.10.10 Risk characterization

A.10.10.1 TAC derivation

The TAC derivation shall contain an explanation of all factors contributing to the TAC calculation, including adjustment for sources of the substance other than water. The TAC calculation shall be based on the oral RfD calculated during the dose response assessment in annex A, section A.10.9.2. The TAC calculation shall include adjustment for significant contributions of the substance from sources other than water (e.g., food and

air). In the absence of data to determine the drinking water contribution of a substance, a default drinking water contribution of 20% shall be applied.

A.10.10.2 STEL derivation

When a short-term exposure level is calculated for a substance, the calculation shall be based on the NOAEL or LOAEL of the selected study (as defined in annex A, section A.5) with adjustment for body weight and daily water consumption of the protected individual, including any sensitive subpopulations. The default body weight and water consumption shall reflect that of a child, in the absence of data that demonstrate that adults are more sensitive to the substance than children. A rationale for the selection of uncertainty factors used in the calculation shall also be provided.

A.10.11 Risk management (SPAC derivation)

The TAC calculation shall form the basis of the SPAC calculation. The SPAC is equal to the TAC for qualitative risk assessments. For quantitative risk assessments, the SPAC shall be calculated as a percentage of the TAC value, based on the estimated total number of sources of the substance in the drinking water treatment and distribution system. In the absence of these data, the SPAC shall be calculated as 10% of the TAC value (default multiple source factor of 10 to account for other sources of the substance in drinking water).

A.10.12 Risk comparisons and conclusions

A review of other evaluations of the substance performed by other organizations (international, national, state or provincial agencies, or other entities) shall be provided. Consistencies and differences between evaluations shall be noted. Any uncertainties in these evaluations shall be discussed. A summary of the overall risk of the substance shall be made, including a discussion about compounds of comparable risk (e.g., similar structure, chemical class) when possible.

A.10.13 References

An alphabetized list of all reviewed citations (both cited and not cited in the assessment) shall be provided in an established format such as that described in *The Chicago Manual of Style*.

A.10.14 Appendices

Supporting documents, complex calculations, data summary tables, unique definitions, and other pertinent information shall be included in appendices to the document.

A.10.15 Peer review

Risk assessments performed to the requirements of this annex shall undergo external peer review (USEPA, 1998) by an independent group of individuals representing toxicological expertise in the regulatory, academic, and industrial sectors, with the exception of the following:

- substances evaluated using the threshold of evaluation (see annex A, section A.7.1);
- substances evaluated to a TAC of 10 µg/L using the qualitative approach and concluded to be non-genotoxic (see annex A, sections A.4.2 and A.7.2); and
- non-regulatory criteria that have already undergone peer review, such as USEPA IRIS assessments.

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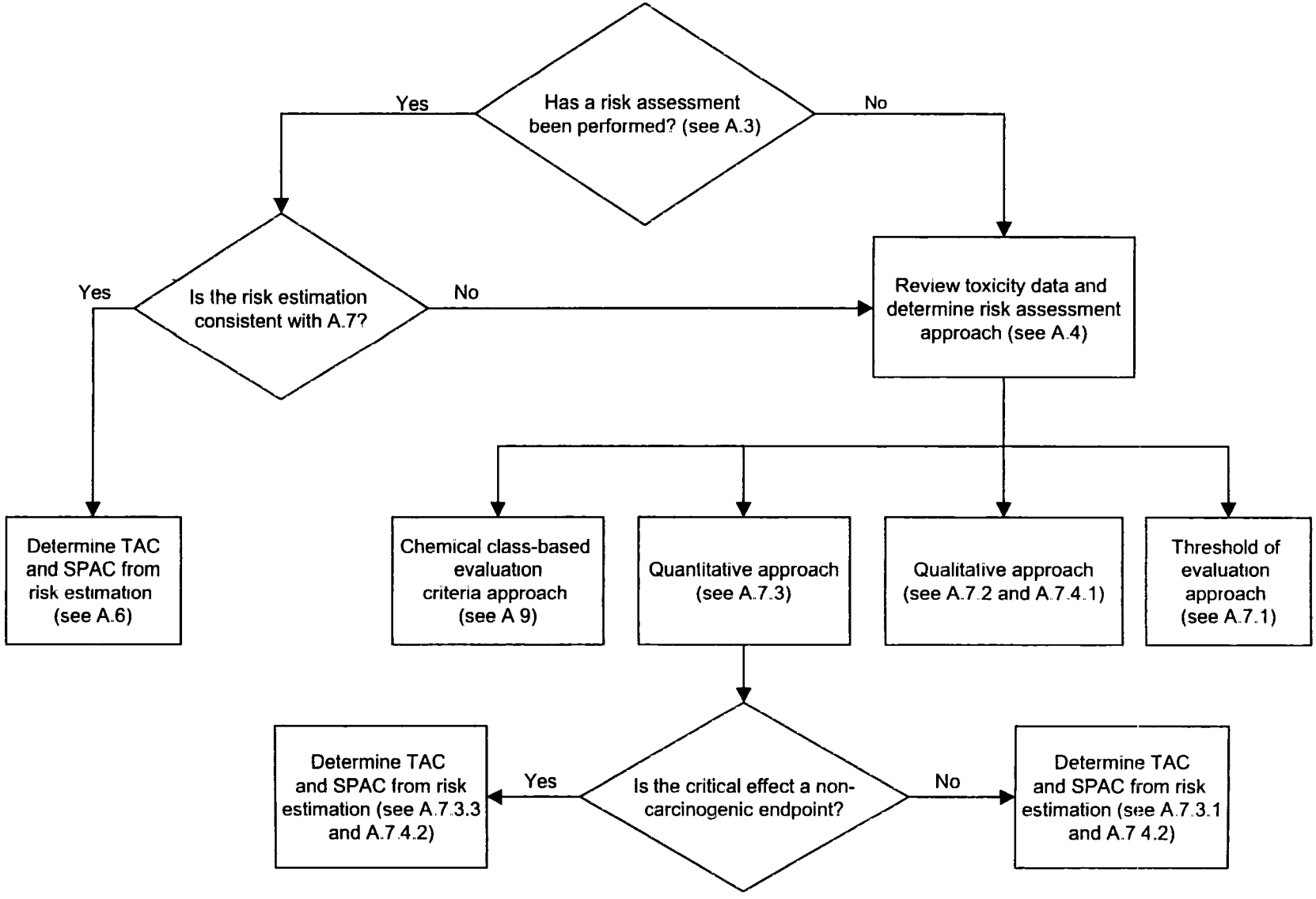

Figure A1 - Annex A toxicity data review process

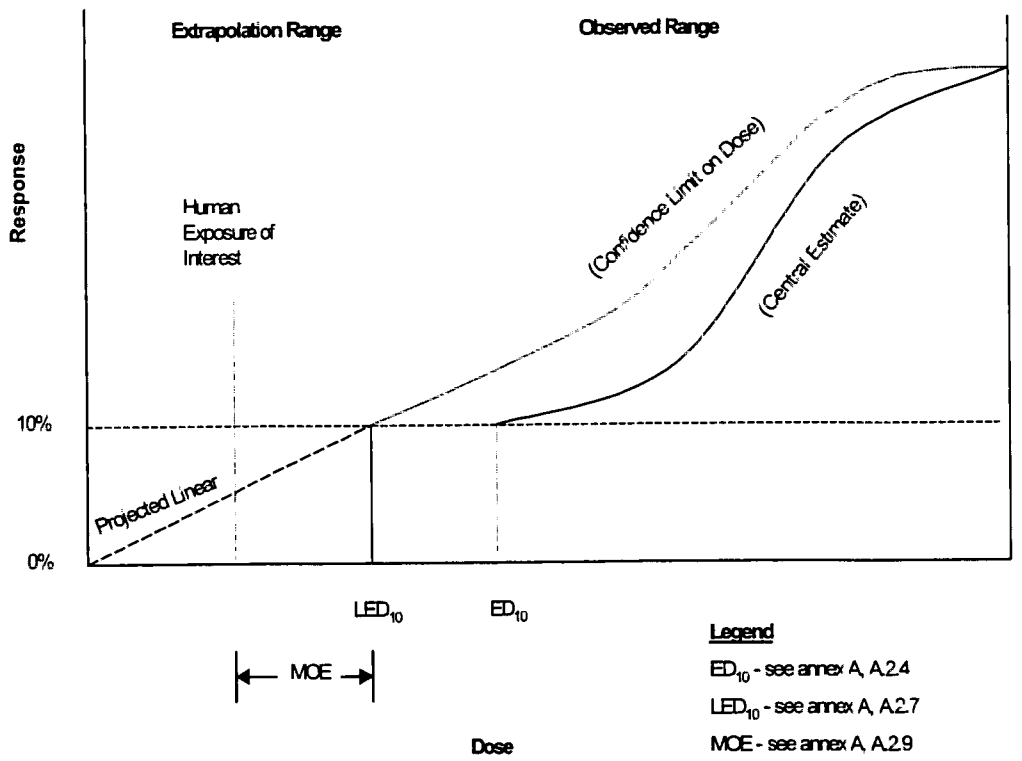

Figure A2 – Graphical presentation of data and extrapolations (USEPA, 1996a)

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Table A1 – Qualitative risk assessment data requirements

Study type	Preferred criteria
Required studies	
gene mutation assay[1]	bacterial reverse mutation assay performed with and without exogenous metabolic activation using *Salmonella typhimurium* (preferred strains are TA97, TA98, TA100, TA102, TA1535, and TA1537) or *Escherichia coli* (preferred strains are WP2 *uvrA* or WP2 *uvrA* (pKM101)
chromosomal aberration assay[1] (*in vitro* preferred)	metaphase analysis in mammalian cells and without exogenous metabolic activation
(*in vivo*)	metaphase analysis or micronucleus assay in mammalian species
Supplemental studies	
supplemental genotoxicity studies	mouse lymphoma assay, SCE[2], UDS[3], HGPRT[4], DNA binding (post labeling assay)
bioaccumulation potential	octanol/water partition coefficient
pharmacokinetics	absorption, distribution, metabolism, and excretion data in humans, other mammalian species, or both
structural/functional assessment	structure/activity relationship analysis
acute or short-term toxicity[5]	1- to 14-d study or 14- to 28-d study using oral exposure route
cell proliferation/cell cycle assays	proliferating cell nuclear antigen (PCNA)
sensitization	guinea pig intradermal injection
in vivo gene mutation assay	transgenic gene mutation assays
endocrine disruption assays	receptor binding/transcriptional activation assays, frog metamorphosis assay, steroidogenesis assay
human data	epidemiological, occupational, or clinical studies

[1] The gene mutation assay and the chromosomal aberration assay (*in vitro* or *in vivo*) shall constitute the minimum data set required to perform a qualitative risk assessment. When one or both *in vitro* genotoxicity studies are positive, the *in vivo* assay shall be required to be reviewed.

[2] Sister chromatid exchange assay; SCEs are not considered to be mutagenic effects because the exchange is assumed to be reciprocal with no gain, loss, or change of genetic material. However, they do indicate that the test material has interacted with the DNA in a way that may lead to chromosome damage. In *in vitro* studies, SCEs do not provide adequate evidence of mutagenicity, but do identify the need for definitive chromosomal aberration studies. When evidence of *in vitro* clastogenicity exists, the induction of SCEs is often used as evidence of likely *in vivo* clastogenic activity because the *in vitro* aberration data demonstrate the clastogenic activity of the compound and the *in vivo* SCE data demonstrate that the compound interacted with the DNA in the target tissue.

[3] Unscheduled DNA synthesis assay

[4] Hypoxanthine guanine phosphoribosyl transferase assay

[5] Minimum reported parameters shall include clinical observations, hematology and clinical chemistry, and gross pathology.

Table A2 – Quantitative risk assessment data requirements

Study type	Preferred criteria
Required studies	
gene mutation assay[1]	bacterial reverse mutation assay performed with and without exogenous metabolic activation using *Salmonella typhimurium* (preferred strains are TA97, TA98, TA100, TA102, TA1535, and TA1537) or *Escherichia coli* (preferred strains are WP2 *uvrA* or WP2 *uvrA* (pKM101)
chromosomal aberration assay[1] (*in vitro* preferred)	metaphase analysis in mammalian cells and without exogenous metabolic activation
(*in vivo*)	metaphase analysis or micronucleus assay in mammalian species
subchronic toxicity[1]	90-d assay in rodent species by oral route of exposure
Additional studies (required as indicated)	
reproduction assay[2]	two generation reproductive assay in a rodent species
developmental assay[2]	teratology study (two species, one rodent and one non-rodent, are preferred)
chronic study[3]	two-year bioassay in rodent species by oral route of exposure
Supplemental studies	
supplemental genotoxicity studies	mouse lymphoma, SCE[4], UDS[5], HGPRT[6], DNA binding (post labeling assay)
bioaccumulation potential	octanol/water partition coefficient
pharmacokinetics	absorption, distribution, metabolism, and excretion data in humans, other mammalian species, or both
structural/functional assessment	structure/activity relationship analysis
acute or short-term toxicity[7]	1- to 14-d or 14- to 28-d study using oral exposure
cell proliferation/cell cycle assays	proliferating cell nuclear antigen (PCNA)
sensitization	guinea pig intradermal injection
in vivo gene mutation assay	transgenic gene mutation assays
endocrine disruption assays	receptor binding/transcriptional activation assays, frog metamorphosis assay, steroidogenesis assay
human data	epidemiological, occupational, or clinical studies

[1] The gene mutation assay, the chromosomal aberration assay (*in vitro* or *in vivo*), and the subchronic toxicity study shall constitute the minimum data set required to perform a quantitative risk assessment. When one or both *in vitro* genotoxicity studies are positive, the *in vivo* assay shall be required to be reviewed.

[2] It is recommended that results of a screening assay, such as OECD No. 422, *Combined repeated dose toxicity study with reproduction/developmental toxicity screening test*, or data from other repeated dose assays that include histopathological examination of the reproductive tissues of each sex be reviewed prior to a determination that these assays are required for evaluation.

[3] A chronic study with evaluation of carcinogenic endpoints is required when review of the minimum data set concludes that the substance is likely to be a human health hazard at exposures of 10 µg/L or less.

[4] Sister chromatid exchange assay. SCEs are not considered to be mutagenic effects because the exchange is assumed to be reciprocal with no gain, loss, or change of genetic material. However, they do indicate that the test material has interacted with the DNA in a way that may lead to chromosome damage. In *in vitro* studies, SCEs do not provide adequate evidence of mutagenicity, but do identify the need for definitive chromosomal aberration studies. When evidence of *in vitro* clastogenicity exists, the induction of SCEs is often used as evidence of likely *in vivo* clastogenic activity because the *in vitro* aberration data demonstrate the clastogenic activity of the compound and the *in vivo* SCE data demonstrate that the compound interacted with the DNA in the target tissue.

[5] Unscheduled DNA synthesis assay

[6] Hypoxanthine guanine phosphoribosyl transferase assay

[7] Minimum reported parameters include clinical observations, hematology and clinical chemistry, and gross pathology

Table A3 – TACs for qualitative risk assessment

Conclusion of data review	TAC
The weight of evidence review of the required genotoxicity studies and all other relevant data concludes that the substance is not a hazard at exposures of 10 µg/L or less	10 µg/L
The weight of evidence review of the required genotoxicity studies, a repeated dose study of less than 90 d duration[1], and all other relevant data concludes that the substance is not a human health hazard at exposures of 50 µg/L or less.	≤ 50 µg/L
The weight of evidence review of the required genotoxicity studies and all other relevant data concludes that the data are insufficient to determine the potential human health hazard of the substance at exposures of 10 µg/L or less.	Supplemental studies or chronic toxicity and carcinogenesis bioassay required for review
The weight of evidence review of the required genotoxicity studies and all other relevant data concludes that the substance is likely to be a human health hazard at exposures of 10 µg/L or less.	Chronic toxicity and carcinogenesis bioassay required for review

[1] Required study parameters include organ and body weights, clinical chemistry and hematology, gross pathology, and histopathology.

Table A4 – Uncertainty factors

Areas of uncertainty	Factor
Intraspecies extrapolation (species variation): This factor accounts for variations in chemical sensitivity among individuals in a species including toxicokinetic and toxicodynamic parameters.	1, 3, or 10
Interspecies extrapolation (animal to human): This factor accounts for variations in chemical sensitivity between experimental animals and humans, including toxicokinetic and toxicodynamic parameters	1, 3, or 10
Less than lifetime duration of exposure: This factor is intended to extrapolate experimental results from subchronic to chronic exposure.	1, 3, or 10
Use of LOAEL rather than NOAEL[1]: This factor addresses the uncertainty in developing a reference dose from a LOAEL rather than a NOAEL.	1, 3, or 10
Lack of database completeness: This factor accounts for the absence of data for specific toxic endpoints.	1, 3, or 10

[1] This adjustment is not required for BMD calculations.

NOTE – When uncertainties exist in four areas, a 3000-fold composite uncertainty factor is appropriate. When uncertainties exist in five areas, a 10,000-fold composite uncertainty factor is appropriate. This consolidation of individual factors recognizes that each individual factor is conservative, and multiplication of four or five uncertainty factors is likely to result in an overly conservative RfD. Datasets that would result in a composite uncertainty factor of greater than 10,000-fold are considered too weak for quantitative risk assessment (see annex A, section A.4.2 for qualitative risk assessment requirements) (Dourson, 1994).

Annex B
(normative)

Product/material evaluation

B.1 Background

Products/materials to be evaluated shall be prepared, exposed, and the extraction medium (e.g., water, chemical) analyzed as described in this annex Examples of products/materials covered by this annex are shown in annex B, table B1.

Table B2 in this annex outlines the various preparation and exposure methods for the products/materials covered by the annex.

The analytical methods included are based on contaminants that are likely to be present when established methods of production are used and the materials are derived from known sources. Modifications to the analytical procedures shall be permitted when products/materials are produced with alternate methods or have originated from alternate sources.

B.2 General evaluation requirements

B.2.1 General

The requirements described in this section are general requirements and apply to all products/materials covered by NSF/ANSI 61, annex B, sections B.3 to B.5 describe specific preparation, conditioning, and exposure sequences unique to individual product/material categories.

B.2.2 QA/QC and safety

The methods included in annex B, sections B.3 to B.5 have been written for trained chemical laboratory personnel. Appropriate quality assurance procedures and safety precautions shall be followed

B.2.3 Samples

B.2.3.1 Material evaluation

A representative sample of the material (in either material sample or finished product form) shall be exposed.

B.2.3.2 Finished product evaluation

Samples of the finished product (e.g. pipe, fitting, device) shall be exposed except in the following specific instances:

- concrete cylinders, cubes, or other concrete surrogate samples shall be permitted to be evaluated on behalf of concrete lined pipes and other concrete-based products;

- coatings, applied to an appropriate substrate, shall be permitted to be evaluated on behalf of products whose entire water contact surface is covered by the coating; and

- finished products, for which finished product evaluation is impractical due to one or more of the following reasons, shall be permitted to be evaluated using material samples:

- an internal volume greater than 20 L (5.3 gal);
- a weight greater than 34 kilos (75 lbs); or
- *in situ* manufacture of the finished product.

Material samples shall be permitted to be evaluated on behalf of a finished product if, and only if, no chemical or physical difference exists between the material sample and the material as represented in the finished product. All material samples shall be produced using all of the same manufacturing processes as the finished product.

B.2.4 Washing

To remove any extraneous debris or contamination that occurred during shipping and handling, samples shall be rinsed with cold tap water prior to testing, followed by a reagent water meeting the requirements of annex B, section B.9.2.1 rinse, unless the manufacturer's instructions direct otherwise. If the exterior of a product is exposed, any printed markings (e.g., ink markings) shall be removed.

B.2.5 Extraction waters

Samples shall be exposed, based on a formulation review and determination of the most severe condition(s), to one or more extraction waters as detailed in table B3, except for mechanical plumbing devices (annex B, section B.5.5). The characteristics and preparation of the waters are described in annex B, section B.9.

B.2.5.1 Exceptions

The manufacturer shall have the option to specifically request a change in the extraction water used, based on the intended application or the materials used in the device/product, provided the manufacturer's use instructions indicate the use limitations.

B.2.5.2 Mechanical devices used in contact with drinking water treatment chemicals

These devices and materials shall be exposed to the chemicals and chemical mixtures that have been specified by the manufacturer.

B.2.5.3 Copper and copper alloys

Pipe and tubing manufactured from copper alloy C12200 shall be exposed in the pH 6.5 (annex B, section B.9.4) and in the pH 10 (annex B, section B.9.7) extraction waters. The manufacturer's use instructions shall indicate this use limitation.

Copper and copper alloy fittings intended to be used with copper pipe and tubing shall be exposed in either the pH 5 or the pH 6.5 exposure waters (at the discretion of the manufacturer) and in the pH 10 exposure water. When electing to use the pH 6.5 exposure water, the manufacturer's literature shall indicate this use limitation.

B.2.6 Product exposure

Samples shall be evaluated either "in-the-product/ device" or in an exposure vessel

B.2.6.1 Exposure in the product/device

When practical, products/devices shall be evaluated such that only the (exposed) wetted surface is exposed to extraction medium

B.2.6.2 Exposure in vessels

Samples that are not evaluated as described in annex B, section B.2.6.1 shall be exposed to the extraction medium in containers composed of a material that is inert to the exposure water and with PTFE (polytetrafluoroethylene) lined lids, with no headspace.

Products exposed in vessels shall be exposed such that the surface area-to-volume ratio described in the appropriate section (annex B, sections B.3 to B 5) shall be maintained.

B.2.6.3 Residual vinyl chloride monomer (RVCM)

Polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) pipe products/materials shall be evaluated for RVCM. RVCM shall be determined in the product wall, rather than by extraction, in accordance with annex B, section B.7.

B.2.7 Material exposure

Materials shall be exposed according to the protocol outlined for the materials' specified end use(s). If a material is intended for use in the manufacture of products covered under more than one section of this standard, the most stringent exposure condition shall be followed (e.g. temperature, surface area-to-volume ratio). A material intended to be processed by more than one method (e.g. injection molding, extrusion, stamping) shall be tested in each of the processed forms

B.2.7.1 Exposure of a material sample

A materials manufacturer shall have the option to request that a material be tested as a material sample (e.g., plaque, sheet) if, and only if, there is no chemical or physical difference in the material characteristics between the material sample and the material as it is used in covered applications. If the material is intended to be used only for the manufacture of products falling under the scope of a single section of this standard, the material shall be exposed under the conditions set forth in the corresponding section of annex B. The normalized contaminant concentrations shall meet the requirements of annex A.

B.2.7.2 Exposure in product form

A materials manufacturer shall have the option to request that a material be tested in the form of a finished product according to the protocol set forth in the appropriate section(s) of annex B.

B.2.7.3 Surface area-to-volume ratio (s/v)

When testing the material in the form of a material sample or in product form, the dimensions of the material or the product sample tested and the extraction medium volume shall be recorded and the laboratory tested surface area-to-volume ratio calculated. When necessary, laboratory extraction results shall be adjusted to reflect the difference between laboratory and field surface-to-area volume ratios.

B.2.8 Exposure conditions

Exposure begins immediately following washing or the appropriate conditioning.

B.2.8.1 Method blanks

Method blanks shall be prepared using the same reagent and in the same manner as product samples, but no product shall be added. An uncoated substrate, as applicable, shall be included. Method blanks shall be processed with all samples.

B.2.8.2 Method standards

Method standards shall be prepared along with all samples. Method standards are prepared in the same manner as method blanks, except a known amount of the expected contaminant is added.

B.2.8.3 Sequential exposure

Tests for evaluation shall be conducted using a sequential exposure procedure. There shall be no significant time interval between exposures (decant, discard, fill, continue exposure). The products shall be exposed depending on the intended end use application, as described in the appropriate section (annex B, sections B.3 to B.5). Analyses shall be performed only on the final extraction medium, unless otherwise noted.

B.3 Joining and sealing materials

B.3.1 Sample requirements

Test samples of joining and sealing materials shall be prepared such that, upon exposure, a minimum surface area-to-volume ratio of 15 cm^2/L (8.8 in^2/gal) is obtained. Materials used at higher surface to volume ratios in the field shall be exposed at the actual use ratio or greater. Test samples for the various types of joining and sealing materials are described in annex B, table B4.

B.3.2 Preparation

Samples shall be prepared so that the entire surface to be exposed is covered by extraction water. Products (as appropriate) shall be applied to a glass panel in a manner consistent with the manufacturer's published instructions. Products requiring a reactive substrate (i.e., when glass is inappropriate), shall be applied to an appropriate alternate substrate.

B.3.2.1 Gasket materials

These products shall be cut to the appropriate size as described in annex B, section B.3.1.

B.3.2.2 Caulks, greases, lubricants, and sealants

These products shall be applied to a glass panel in such a manner that an even film, consistent with end use, is exposed and the surface area-to-volume ratio described in annex B, section B.3.1 is maintained. The slides shall be allowed to air dry or cure according to the manufacturer's published instructions.

B.3.2.3 Adhesives and cements

B.3.2.3.1 Adhesives and cements intended for joining pipe and fittings shall be prepared as pipe and fittings joints assembled in accordance with the manufacturer's use instructions. The joints shall be produced using 2 in nominal diameter pipe (or tubing) and fittings, or the minimum size specified by the manufacturer, if it is greater. Unless otherwise stated in the manufacturer's use instructions, PVC pipe and fitting joints shall be assembled per ASTM D2855 and CPVC pipe and fitting joints assembled per appendix XI of ASTM F493. If the manufacturer's use instructions recommend use of a primer, testing shall incorporate use of a primer. Unless otherwise stated in the manufacturer's use instructions, joints shall be allowed to air cure for 48 ± 2 h at room temperature prior to washing, conditioning, and exposure in-product.

B.3.2.3.2 Adhesives and cements not intended for joining pipes and fittings shall be prepared in a manner consistent with the manufacturer's use instructions. These products shall be applied to glass panels (or manufacturer's intended substrate) such that an even film, consistent with end use, is exposed at a field surface area-to-volume ratio greater than or equal to a typical installation. Unless otherwise indicated in the manufacturer's use instructions, the slides shall be allowed to air cure for 48 ± 2 h at room temperature prior to washing, conditioning, and exposure in-vessel.

B.3.2.4 Solders

These products shall be prepared by placing the solder in a ceramic combustion boat (96 mm x 12 mm x 10 mm) The amount of solder used shall be sufficient to cover the bottom of the boat. The boat (with solder) is then placed in a muffle furnace that has been set to a temperature that is 20 °C (36 °F) above the liquidus temperature of the product being evaluated For example:

- 95/5 tin/antimony solder has a melting range of 232 to 240 °C (450 to 464 °F). The oven is set at 260 °C (500 °F) for this solder.

The boat (with solder) is placed in the oven and allowed to heat until the solder has melted (approximately 1 - 2 min). The boat is allowed to cool and the solder piece is removed

B.3.2.5 Fluxes

These products shall be prepared by applying a thin film to a copper sheet of the appropriate size as described in annex B, section B.3.1. The copper sheet is then placed in a muffle furnace that has been set to 300 °C (572 °F). The copper sheet (with flux) is allowed to heat until the flux flows (approximately 30 to 60 sec). The copper sheet is allowed to cool prior to exposure.

B.3.3 Conditioning for joining and sealing materials intended for joining pipe and fittings

Following washing (annex B, section B.2.4), and prior to exposure, product/material samples shall be conditioned to simulate pre-use flushing and disinfection procedures. The samples shall be exposed for evaluation immediately after conditioning. Joining and sealing materials shall be conditioned at the temperature appropriate for the intended end use. The product samples shall be conditioned in accordance with 4 5.5 for single time point evaluations and 4.5.7 for multiple time point evaluations

B.3.4 Conditioning for all other joining and sealing materials

Following preparation, the test samples are washed as described in annex B, section B.2 4

B.3.5 Exposure for joining and sealing materials intended for joining pipe and fittings

Exposure shall begin immediately following conditioning. The samples shall be exposed to the appropriate extraction water, annex B, section B.2.5, based on end use or application. The product samples shall be exposed in accordance with 4.5.6 for single time point evaluations or in accordance with 4 5.7 for multiple time point evaluations. The extraction water shall be collected for analysis as described in annex B, section B 6.

B.3.6 Exposure for all other joining and sealing materials

Following conditioning, these materials shall be exposed in the appropriate extraction water, annex B, section B 2 5, in accordance with the intended end use application as described below. The extraction water samples shall be collected as described in annex B, section B.6.

B.3.6.1 Cold application

Products to be evaluated for cold applications shall be exposed using the sequence in table B5.

B.3.6.2 Hot application samples

Products to be evaluated for hot applications shall be exposed using the sequence in table B6.

B.3.7 Extended exposure

If the normalized concentration of a contaminant exceeds the annex A criteria (chronic exposure), the manufacturer shall be permitted to request that additional exposure testing be undertaken. The additional testing shall be used to determine a contaminant leaching rate(s) over time. The relationship between contaminant concentration and time shall be determined, plotted with a minimum of five points, and then used for evaluation. When feasible, testing shall continue until contaminant concentrations are reduced to 10% of the initial contaminant concentration. The normalized contaminant concentrations shall then be compared to the SPAC as specified in annex A, section A.5 (potential exposure resulting from short-term high level leachates).

B.4 Mechanical devices

B.4.1 Samples

Samples shall consist of the entire device, or portion(s)/ component(s) of the device, or a specimen of the material(s). The manufacturer shall have the option to request that the samples represent a product line of varying sizes, as described below. When it is necessary to calculate normalization factor(s), the wetted exposed surface area of the sample shall be calculated and recorded prior to testing

B.4.1.1 Entire device

A single device shall represent a product line of varying sizes when:

- materials are of the same alloy, composition, or formulation; and
- materials have undergone the same manufacturing process, e.g., casting, extrusion; and
- designs are analogous; and
- it has the greatest exposed wetted surface area-to-volume ratio.

The wetted surface area-to-volume ratio shall be calculated as $SA_F/V_{F(static)}$, with SA_F equal to the surface area exposed in the field, and $V_{F(static)}$ equal to the volume of water to which the device is exposed under the static condition. The surface area-to-volume ratio for a device having an internal volume of less than 1 L (0.26 gal) shall be calculated with the assumption that $V_{F(static)}$ is equal to 1 L (0.26 gal).

NOTE 1 – For a product line of varying sizes having volumes of less than 1 L (0.26 gal), the device with the largest wetted surface area will be the device having the greatest exposed surface area to volume ratio

NOTE 2 – Design differences such as external and internal threaded outlets shall not be considered analogous.

NOTE 3 – For internal threaded products, SA_F shall be equal to the normally wetted surface area of the product including 25% of the threaded area(s) The capacity of the product shall be equal to the volume of water contacted by the wetted surface area of the product including the volume contained within 25% of the threaded area(s). When the product capacity is less than 1 L (0.26 gal), $V_{F(static)}$ shall equal 1 L (0.26 gal). When the product capacity is equal to or greater than 1 L (0.26 gal), $V_{F(static)}$ shall be equal to the capacity.

B.4.1.2 Component

A component shall represent a product line of varying sizes when:

- materials are of the same alloy, composition, or formulation; and
- materials have undergone the same manufacturing process, e.g., casting, extrusion; and
- designs are analogous; and
- it has the greatest exposed wetted surface area-to-volume ratio.

The wetted surface area-to-volume ratio shall be calculated as $SA_F/V_{F(static)}$, with SA_F equal to the surface area exposed in the field, and $V_{F(static)}$ equal to the volume of water to which the component is exposed under the

static condition. The surface area-to-volume ratio for a component having an internal volume of less than 1 L (0.26 gal) shall be calculated with the assumption that $V_{F(static)}$ is equal to 1 L (0.26 gal).

NOTE 1 – For a product line of varying sizes having volumes of less than 1 L (0.26 gal), the component with the largest wetted surface area will be the component having the greatest exposed surface area to volume ratio.

NOTE 2 – Design differences such as external and internal threaded outlets shall not be considered analogous.

NOTE 3 – For internal threaded products, SA_F shall be equal to the normally wetted surface area of the product including 25% of the threaded area(s). The capacity of the product shall be equal to the volume of water contacted by the wetted surface area of the product including the volume contained within 25% of the threaded area(s). When the product capacity is less than 1 L (0.26 gal), $V_{F(static)}$ shall equal 1 L (0.26 gal). When the product capacity is equal to or greater than 1 L (0.26 gal), $V_{F(static)}$ shall be equal to the capacity.

B.4.1.3 Material

The material shall be representative of that used in the component or device.

Materials shall be evaluated using a minimum surface area-to-volume ratio of 50 cm^2/L.

B.4.2 Sample preparation

Prior to conditioning and exposure, the samples shall be washed as described in annex B, section B.2.4, unless the manufacturer's instructions direct otherwise. When required, the device shall be properly prepared per the manufacturer's recommendations.

When the test sample contains internal threaded outlets, 75% of the threaded surface area(s) shall be covered by insertion of a threaded component of the appropriate diameter to produce a water tight seal. The threaded component shall also be present in the method blank (see Annex B, section B.2.8.1).

NOTE – To facilitate the exposure of product samples that are connected to pipe or tubing products under normal installation conditions (e.g., valves), the samples may be attached to lengths of pipe or tubing of the appropriate nominal diameter. When preparing a test sample in this manner, the assembly shall be designed such that the volume of the test sample plus the attached pipe or tubing is equal to the $V_{F(static)}$ for the product. The pipe or tubing material shall also be present in the method blank as required in annex B, section B.2.8.1.

B.4.3 Conditioning

Conditioning shall be conducted either in the device or in a vessel. Table B6 provides examples of typical exposures for the various products covered by this section. The test samples shall be preconditioned by exposure at room temperature 23 ± 2 °C (73 ± 4 °F) to the extraction water used for testing (annex B, section B.2.5) for 14 d or less if specified by the manufacturer. The water shall be changed at least 10 times (during the 14-d conditioning period), or less if specified by the manufacturer. There shall be a minimum period of 24 h per exposure.

B.4.4 Exposure

B.4.4.1 In-line device samples

Following conditioning, the samples shall be exposed as described in annex B, table B7 in the appropriate extraction media (annex B, section B.2.5). Devices/components that in actual field use are not used with hot water shall be exposed using the sequence shown in annex B, table B7. Devices/components that are used in contact with water at a temperature in excess of 23 °C (73 °F) shall be exposed using the same exposure sequence, at the maximum temperature encountered under use conditions. At the conclusion of each of the first two exposure periods defined in annex B, table B7, the extractant water shall be discarded. The test sample or exposure vessel shall then be refilled with exposure water, and the exposure continued. At the

conclusion of the third exposure period, the extraction media shall be collected as described in annex B, section B.6.

B.4.4.2 Chemical feeder and generator exposure

The samples shall be exposed to the appropriate drinking water treatment chemical or chemical mixture for a minimum of four (4) hours (or for a longer period as recommended by the manufacturer) at 23 ± 2 °C (73 ± 4 °F). For devices that normally operate at lower or higher temperatures, the exposure shall be at the normal operating temperature. The extractant shall be collected in a vessel appropriate for shipping and storage. For chemical feeders, a sample of the chemical prior to feeding shall be collected if possible. For chemical generators, samples of the raw chemicals shall be collected. For all devices where the extractant is a mixture of water and the chemical(s), a sample of the influent water shall be collected and preserved as described in annex B, section B.6. Analysis of the extractant shall be in accordance with the requirements of NSF/ANSI 60, Drinking Water Treatment Chemicals - Health Effects. Samples of the chemicals prior to feeding samples of raw materials, and influent water samples shall be analyzed for background levels of contaminants only if, after normalization, the concentration of a contaminant(s) exceeds the SPAC (annex B, section B.8.6).

B.4.4.3 Other mechanical devices

Following conditioning, other mechanical devices shall be exposed using the appropriate extraction media (annex B, section B.2.5) as indicated in annex B, table B8. Devices that in actual field use are not used with hot water (e.g., distribution system valves), shall be exposed using the sequence shown in annex B, table B8. At the conclusion of each of the first two exposure periods defined in annex B, table B8, the extractant water shall be discarded. The test sample or exposure vessel shall then be refilled with exposure water, and the exposure continued. At the conclusion of the third exposure period, the extraction media shall be collected as described in annex B, section B.6.

B.5 Mechanical plumbing devices

B.5.1 Samples

Samples shall consist of the entire device, portion(s)/component(s) of the device, or a specimen of the materials(s) of the device. The samples shall be permitted to represent a product line of varying sizes, as described in annex B, sections B.5.1.1 and B.5.1.2. When it is necessary to calculate normalization factor(s), the wetted surface area of the sample shall be determined. When testing materials and components using in-vessel exposure, the actual wetted surface area and the volume of water in the extraction vessel shall be determined.

B.5.1.1 Device

A single device shall represent a product line of varying sizes when the following requirements are met:

- materials are of the same alloy, composition, or formulation;
- design and manufacturing processes are analogous; and
- it has the greatest wetted surface area-to-volume ratio.

The surface area-to-volume ratio for an endpoint device, other than a commercial kitchen device, shall be calculated with the assumption that the device volume is 1 L (0.26 gal). The surface area-to-volume ratio for a commercial kitchen device shall be calculated with the assumption that the device volume is 18.9 L (5 gal).

B.5.1.2 Component

A component shall represent a product line of varying sizes when the following requirements are met:

- materials are of the same alloy, composition, or formulation;

- design and manufacturing processes are analogous; and
- it has the greatest wetted surface area-to-volume ratio

The surface area-to-volume ratio for a regular endpoint component shall be calculated with the assumption that the component volume is 1 L (0.26 gal).

B.5.1.3 Material

The material shall be representative of that used in the component or device. Material samples not related to a specific component or device can also be evaluated

B.5.2 Washing

Flush device for 15 min with tap water under pressure, then rinse with 3 volumes of reagent water, meeting the requirements of annex B, section B.9.2. Alternate preparation of the device shall be performed when required by published manufacturer's instructions. Components and materials shall be washed according to annex B, section B.2.4.

B.5.3 Conditioning

Conditioning of the sample shall be performed in the sample or in a vessel Endpoint devices, components, and materials shall be conditioned by rinsing with 3 volumes of extraction water (specified in annex B, section B.5.5) at room temperature 23 ± 2 °C (73 ± 4 °F). The units or exposure vessels shall be filled with extractant water and held until the start of the exposure sequence for a period not to exceed 72 h

B.5.4 Exposure

Following conditioning, the sample shall be exposed to extraction water according to the applicable scheme detailed in annex B, sections B.5.4.1 through B.5.4.3. Reflecting the sample's intended use, samples shall be exposed to extraction waters at the specified temperatures for the entire duration of the exposure Exposure shall be limited to 23 ± 2 °C (73 ± 4 °F) except for instant hot water dispensers, in which case the manufacturer's specified thermostat setting shall be used.

Evaluation of endpoint devices, components, and materials for contaminants other than lead shall require exposure of at least one sample according to the timetable of figure B1. The number of products to be tested shall be specified by the manufacturer. When one sample is tested, the normalized contaminant concentrations from exposure on Day 19 shall be compared to their respective SPACs If more than one sample is tested, the geometric mean of normalized contaminant concentrations from exposure on Day 19 shall be compared to their respective SPACs.

Evaluation of endpoint devices, components and materials for the contaminant lead shall require exposure of at least 3 devices (more if specified by the manufacturer), according to the timetable of figure B1 It is recommended that product lines thought to be marginally acceptable, and those that leach levels of lead approaching the maximum allowable level, should be tested for more than the minimum number of products The rationale for selecting a number greater than 3 products is provided in annex B, section B.8.9. On Days 3, 4, 5, 10, 11, 12, 17, 18, and 19, the 16 h dwell extractant water shall be collected. The lead test statistic Q shall be determined as described in annex B, section B.8.9 and compared to 11 µg.

When additional extraction water is needed to complete all analyses, additional samples shall be exposed.

B.5.4.1 Exposure sequence for endpoint devices

The device shall be inverted and filled with extraction water and held according to figure B1 during the exposure sequence. Hot water dispensers shall be heated to operating temperature, then exposed following the sequence in figure B1 at the elevated temperature.

The final exposure water shall be collected and preserved in accordance with applicable analytical methods. Only the contaminant levels present in the 16 h dwell samples shall be used to evaluate the product's leaching characteristics

For endpoint devices, the exposure sequence in figure B1 shall be conducted and the Days 3, 4, 5, 10, 11, 12, 17, 18, and 19 lead dosages shall be determined.

B.5.4.2 Exposure sequence for components and materials

The exposure procedures provided in annex B, section B.5.4.1 shall be followed. Samples shall be tested at a surface area-to-volume ratio at least as high as the ratio that exists in the device.

B.5.4.3 Method blanks

Method blanks are prepared using the same reagents and in the same manner as samples, but no sample is added. An uncoated substrate, as applicable, shall be included. Method blanks shall be processed with all samples.

B.5.4.4 Method standards

Method standards shall be prepared along with all samples. Method standards are prepared in the same manner as method blanks, except a known amount of the expected contaminants is added.

B.5.5 Extraction water

The extraction water shall be prepared by combining:

- 25 ml of 0.4M sodium bicarbonate;
- chlorine stock solution as per annex B, section B.9.2.4;
- reagent water meeting the requirements of annex B, section B.9.2.1 (make up to 1 L), and adjust pH as needed using 0.1M HCl; and
- this water shall have a pH of 8.0 ± 0.5, alkalinity of 500 ± 25 ppm, dissolved inorganic carbon of 122 ± 5 ppm, and 2 ± 0.5 ppm of free chlorine.

B.6 Collection and preservation of extraction media following exposure

Immediately following the exposure period, the extraction media shall be poured into sample bottles previously prepared as detailed in annex B, table B8 for storage until analysis. The procedures described in annex B, table B8 are based on collection methods included in "Manual For The Certification of Laboratories Analyzing Drinking Water," (EPA-570/9-82-002) and *Standard Methods For The Examination of Water and Wastewater* (most recent edition).

B.7 Analysis methods

B.7.1 General

This section is divided into five parts: metals, organics, (other than residual vinyl chloride monomer (RVCM) and solvent), radionuclides, RVCM, and solvents analyses. The specific analyses performed shall be formulation dependent.

Each testing organization shall periodically review the analytical methods it uses to ensure that applicable advances in analytical methodologies are instituted.

B.7.2 Definitions

B.7.2.1 identified compound with standard: A compound identification made based on the daily analysis (initial or continuing calibration) of an authentic standard of an analyte. Retention time and mass spectrum are used for qualitative determination of the analyte. A calibration curve is used for quantitative determination of the analyte.

B.7.2.2 identified compound without standard: A compound identification based on mass spectral matches between the analyte and mass spectral libraries (commercial or private), or based on spectral interpretation by a qualified chemist, or both. The quantitative determination is made through direct correlation between the analyte response and the nearest internal standard response.

B.7.2.3 matrix spike: An aliquot of a sample matrix fortified with a known quantity of analyte.

B.7.2.4 method detection limit (MDL): As defined in 40 CFR Part 136, Appendix B, the minimum concentration of a substance that can be measured and reported with 99% confidence that the substance concentration is greater than zero. The MDL is determined from analysis of a minimum of seven aliquots of standard (known quantity of analyte in reagent matrix) at concentrations that are in the range of the estimated detection limit.

B.7.2.5 method validation: Verification of an analytical procedure performed by determining the method detection limit (see annex B, section B.7.2.4).

B.7.2.6 reporting limit (RL): The lowest concentration of analyte that can be reliably reported.

B.7.2.7 unknown: An analyte for which an identification cannot be determined. Information on chemical class, functional group(s), and chemical structure may be determined by spectral interpretation.

B.7.3 Metals analysis

Analyses for metals shall be performed, except as otherwise provided for herein, in accordance with currently accepted U.S. Environmental Protection Agency (EPA) Methods (see 40 CFR Part 141 and Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020). When no EPA method is provided, analyses shall be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* (most current edition). If neither of these two references address the required parameters and matrix, or if an alternate method is desired, method validation shall be completed prior to the application of the method (see annex B, section B.7.2.5).

B.7.4 Organics analysis

B.7.4.1 General requirements for analysis of organics

Analyses for organics shall be performed, except as otherwise provided for herein, in accordance with currently accepted EPA methods (see 40 CFR Part 141 and Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020). When no EPA method is provided, analyses shall be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* (most current edition). If neither of these two references address the required parameters and matrix, or if an alternate method is desired, method validation shall be completed prior to the application of the method (see annex B, section B.7.2.5).

B.7.4.2 Gas chromatography/mass spectroscopy (GC/MS) analysis

B.7.4.2.1 General requirements for GC/MS analysis

The minimum instrument operation requirements for GC/MS analysis shall be in accordance with USEPA Method 625 with the addition of the following modifications:

– The average chromatographic peak area of each internal standard in the calibration curve shall be determined. The chromatographic peak area of each internal standard in the continuing calibration shall be greater than 50% and not more than 200% of that average;

– While performing a continuing calibration check (CCC), concentrations of 10% of the target compounds for each analysis (e.g. base/neutral, base/neutral/acid, acid) shall be allowed to fall outside of the range of 70% to 130% (outlier) of the true value. None of the concentrations shall be allowed to fall below 50% or above 200% of the true value. If a positive sample analyte result is identified for any outlier, a second CCC shall be performed. If the second CCC determines the sample analyte result to no longer be an outlier, the sample shall be reanalyzed. However, if the second CCC also determines the analyte to be an outlier, a new calibration curve shall be determined and the sample shall be reanalyzed;

– If commercially available mass spectral libraries are utilized, a minimum size of 100,000 compounds shall be required; and

– The testing laboratory shall report the compounds detected during GC/MS analysis as one of the following:

  – identified compound with standard (see annex B, section B.7.2.1);

  – identified compound without standard (see annex B, section B.7.2.2); or

  – unknown (see annex B, section B.7.2.7).

B.7.4.2.2 Requirements for identified compounds with standards via GC/MS analysis

Contaminants that have been identified and quantified by comparison to authentic standards shall be normalized in accordance with the requirements of this Standard (see annex B, section B.8). The normalized contaminant concentration shall be compared to the acceptable exposure concentration as determined in accordance with annex A of this Standard.

B.7.4.2.3 Requirements for identified compounds without standards via GC/MS analysis

Contaminants that have been identified and quantified by comparison to a known mass spectrum, or by spectral interpretation by a qualified chemist, or both, shall be normalized in accordance with the requirements of this Standard (see annex B, section B.8). The normalized contaminant concentration shall be compared to the acceptable exposure concentration as determined in accordance with annex A of this Standard. In addition, the product manufacturer shall assist the testing laboratory in the identification of an authentic standard for the compound and an appropriate analytical method, if applicable, so that confirmatory identification and quantification can be performed.

B.7.4.2.4 Requirements for unknowns via GC/MS analysis

Contaminants detected by GC/MS analysis, but that are not identified and quantified against a known mass spectrum or authentic standard, shall be evaluated as follows:

a) The product material formulation(s) shall be reviewed for potential identification of the unknown contaminant(s) as an ingredient or by-product,

b) The manufacturer shall be notified and requested to provide supporting information that enables identification of the unknown contaminant(s);

c) Structure activity relationships (SAR) shall be utilized when sufficient structural identification of the unknown contaminant(s) can be made; and

d) Alternative methods of analysis that may identify the unknown contaminant(s) shall be considered.

Contaminants that can be identified after performing one or more of the above steps shall be normalized in accordance with the requirements of this Standard (see annex B, section B.8). The normalized contaminant concentration shall be compared to the acceptable exposure concentration as determined in accordance with annex A of this standard. In addition, the product manufacturer shall assist the testing laboratory in the identification of an authentic standard for the compound and an appropriate analytical method, if applicable, so that confirmatory identification and quantification can be performed.

Contaminants detected by GC/MS analysis for which no identification can be made after performing the above steps shall not be considered in the determination of product compliance to this standard. When unknown contaminants are detected in the extractant water, the testing laboratory shall report the analytical results to the product manufacturer

NOTE – The product manufacturer should assist the testing laboratory in a continuing effort to identify the unknown contaminant(s) until specific identification is achieved.

B.7.4.3 Polynuclear aromatic hydrocarbon (PNA) analysis

Analysis for polynuclear aromatic hydrocarbons (PNAs) shall be in accordance with EPA Method 525.2.

B.7.4.4 Phenol and minimally substituted phenols

Analysis for phenol and minimally substituted phenols shall be in accordance with EPA Method 420.2. Analysis for maximally substituted phenols shall be performed by GC/MS base/acid scan (see annex B, section B.7.4.2).

B.7.5 Radionuclides analysis

Analyses for radionuclides shall be performed in accordance with Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032. When no EPA method is provided, analyses shall be performed in accordance with *Standard Methods for the of Water and Wastewater* (most current edition). If neither of these two references address the required parameters and matrix, or if an alternate method is desired, method validation shall be completed prior to the application of the method (see annex B, section B.7.2.5).

B.7.6 RVCM analysis

B.7.6.1 General requirements for RVCM analysis

This method covers the analysis of residual vinyl chloride monomer (RVCM) in PVC and CPVC potable water products using gas chromatography. Method sensitivity is 0.5 ppm (mg/kg) when analyzing 0.5 g of plastic material, using flame ionization detector (FID).

B.7.6.2 Extraction of samples for RVCM analysis

Polyvinyl chloride (PVC) and chlorinate'd polyvinyl chloride (CPVC) products shall be evaluated for RVCM in the product wall. The RVCM concentration shall be determined in the wall, rather than in the extraction water, because very low levels of vinyl chloride cannot be as reliably detected in the extraction water.

B.7.6.2.1 Sample preparation for RVCM analysis

PVC and CPVC samples shall be prepared as described in the following procedure All samples shall be prepared in duplicate

a) Chop a section of PVC or CPVC product sample into coarse pieces

b) Weigh 0 500 ± 0 005 g of chopped sample pieces into a 20 mL glass vial

NOTE – The weight of the sample and the duplicate should not differ by more than 0.005 g.

c) Add 10 mL of N,N-dimethylacetamide (distilled in glass) to the sample bottle, seal and cap.

d) Shake sample bottle at least 30 min on a reciprocating shaker.

B.7.6.2.2 Standards for RVCM analysis

Both a standard stock solution and a secondary dilution standard shall be prepared for the RVCM analysis, using vinyl chloride gas (99.9%) and N,N-dimethylacetamide (DMAC)

B.7.6.2.3 Standard stock solution for RVCM

The standard stock solution shall be prepared as follows:

a) Pipette approximately 9 8 mL of DMAC into a 10 mL volumetric flask

b) Allow the flask to stand unstoppered until the wetted surface has dried

c) Weigh the flask and stopper to the nearest 0.1 mg and record the weight

d) Fill a 50 mL valved gas-tight syringe with vinyl chloride gas to the 50 mL mark.

e) Lower the needle to 5 mm above the meniscus of the DMAC and slowly introduce the standard above the surface.

f) Immediately reweigh the flask and contents and record the weight.

g) Dilute to volume with DMAC, stopper, and mix.

h) Transfer the solution into a PTFE sealed screw-cap vial.

I) Store at -10 °C to -20 °C (14 °F to -4 °F)

j) Calculate stock standard solution with respect to a 0.500 g sample as follows:

$$\frac{(\text{gram of vinyl chloride})\ (1 \times 10^6)}{0.500\ \text{g}} = \text{ppm (mg/kg) (mg/day)}$$

B.7.6.2.4 Secondary dilution standard for RVCM analysis

Using the stock standard solution, a secondary dilution in DMAC shall be prepared that is representative of a concentration suitable for making calibration standards and spikes.

B.7.6.3 Apparatus for RVCM analysis

The following apparatus shall be used for RVCM analysis:

– Gas Chromatograph (GC) - equipped with a mL headspace sampling system, 80 °C (176 °F) oil bath, FID, data recording system, autosampler;

– Column: 6 ft x 2 mm ID glass column packed with 1% SP-1000 on Carbopack B 60/80 mesh Equivalent columns shall be permitted as long as the column provides maximum separation from interferences and the ability to meet established accuracy and precision;

– GC Conditions: The analysis shall be performed using an oven temperature program whereby the initial temperature of approximately 70 °C (158 °F) is held for 5 min, increased at 70°C/min (158°F/min) to approximately 220 °C (428 °F) and held until DMAC elutes (total run time about 16 min);

– The injector, detector, and sample loop temperature shall be held at approximately 200 °C, 275 °C, and 80 °C, (392 °F, 527 °F, and 176 °F) respectively; and

– The helium carrier gas shall have a flow rate of 20 mL/min. The headspace shall have a flow rate of 5 mL/min. The hydrogen and air flows for the flame shall be approximately 30 and 400 mL/min, respectively

NOTE – All of these flow rates will vary somewhat between GCs to optimize separation and response. The above are given only as guidelines.

B.7.6.4 RVCM analysis

The sample and standards prepared in annex B, sections B.7.6.2.1 and B.7.6.2.2 shall be loaded into an auto sampler and equilibrated to 80 °C (176 °F) for 10 min prior to analysis.

B.7.6.5 Quality control for RVCM analysis

Duplicate analysis shall be performed on each sample. Duplicate spiked samples shall be run at the rate of one (1) set per 10 samples. An instrument standard is run with every 10 analyses (5th sample), and a reagent blank is required for each sample set. Quality control charts shall be developed and maintained and used as a check on the analytical system.

B.7.6.6 Evaluation and pass/fail criteria for RVCM analysis

PVC and CPVC products, with an RVCM concentration of less than or equal to 3.2 mg/kg, shall be considered acceptable. This acceptance criteria was determined using the equation described below:

$$M_W = 4/r\,[D/\pi]^{0.5}\,[(t + t_0)^{0.5} - t^{0.5}]M_P,$$

where:

M_W = RVCM diffused into water (mg/L);

M_P = RVCM concentration in the PVC wall (mg/kg);

NOTE – A factor of 1.4 corrects for the ratio of density of water to PVC.

R = pipe radius (cm);
D = diffusivity constant,

where:

$D = D_0 \times e^{(-17{,}000/RT)}$;
R = gas constant 1.987°K^{-1};

T = temperature (°K);
D_0 = 3 7 cm^2/sec (319680 cm^2/d);
t_0 = diffusion time period (d);
t = product age at beginning of the diffusion time (d); and
30 °C = 303 °K.

The calculations shall be as follows:

$$M_W = 4/r\,[D/\pi]^{0.5}\,[(t + t_0)^{0.5} - t^{0.5}](M_P \times 1.4\ kg/L)$$

$$M_P = \frac{M_W}{4/r\,[D/\pi]^{0.5}\,[(t + t_0)^{0.5} - t^{0.5}]\,(1.4\ kg/L)}$$

$$M_P = \frac{0.0002\ mg/L}{(3.15)(0.000235)(0.061)(1.4\ kg/L)}$$

$$M_P = 3.2\ mg/kg$$

NOTE – the following assumptions were used in the preceding calculations:

- 30-d-old product is tested equivalent to 1 in inner pipe diameter;
- t_0 = 16 h (0.67 d); and
- M_W = 0.2 µg/L (0.0002 mg/L).[3]

B.7.7 Solvent analysis

This section outlines the general procedure for determining solvent levels in the extraction water. The method described below is based on direct injection gas chromatography with flame ionization detection (FID). In some instances, an enhancement step (e.g., purge and trap [cold or heated], headspace analysis) shall be required to complete the analysis. The choice of enhancement shall be dependent on the desired detection levels of the solvent of interest. The method sensitivity for direct injection is approximately 100 µg/L (0.1 mg/L) for selected solvents.[1)]

B.7.7.1 General requirements for solvent-containing materials

These products shall be evaluated to determine the solvent leaching rates over time, if applicable. The relationship between contaminant concentration and time shall be determined by plotting a minimum of five points. In many instances, direct injection shall be sufficient only for the early testing period. When direct injection is no longer adequate for determining a concentration, a more sensitive method shall be required (i.e., purge and trap).

B.7.7.2 Apparatus for solvent analysis

The recommended apparatus shall be a gas chromatograph (GC) equipped with an FID, temperature programming, data recording system, and an autosampler. A purge and trap (with and without heat) system and headspace sampling system shall also be available.

NOTE – The analysis conditions may require adjustment relative to the specific solvent or solvent system being evaluated.

[3] This concentration is based on the USEPA MCL for vinyl chloride (2 µg/L or 0.002 mg/L), and since the SPAC = 1/10 MCL, the SPAC = 0.2 µg/L, or 0.0002 mg/L.

B.7.7.3 Quality control for solvent analysis

Duplicate matrix spike samples shall be run at the rate of one (1) set per 10 samples or less. An instrument standard shall be run with every 10 samples and a reagent blank shall be required for each daily analysis. Quality control charts shall be developed, maintained, and used as a check on the analytical system

B.8 Normalization

B.8.1 General

This section provides the calculations used to determine the level of contaminants projected "at the tap" based on the level of contaminants identified during laboratory analysis. The normalized contaminant concentration shall be compared to the requirements established in annex A.

B.8.2 Definitions

B.8.2.1 residential: Products used in buildings.

B.8.2.2 service line: Products used from the water main to building plumbing systems.

B.8.2.3 multiple user service line: Products used between the water main and multiple family residences or commercial buildings.

B.8.2.4 water main (distribution): Products used in locations other than buildings or service lines.

B.8.2.5 multiple-installation products: Products present in the drinking water system at regularly repeating intervals.

B.8.3 Normalization factor

To account for any differences in surface area-to-volume ratios between laboratory and actual field use conditions, an adjustment or conversion may be needed using the equation below:

$$NF = N1 \times N2$$

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}}$$

$$N2 = \frac{V_{F(static)}}{V_{F(flowing)}}$$

where:

SA_F = surface area exposed in the field;

SA_L = surface area exposed in the laboratory;

V_L = volume of extraction water used in the laboratory;

$V_{F(static)}$ = volume of water the product is exposed to in the field for the static condition; and

$V_{F(flow)}$ = volume of water the product is exposed to in the field under flow conditions during a period of time equivalent to the laboratory test.

B.8.3.1 Static condition

The contaminant concentration shall be adjusted to reflect differences in surface area-to-volume relationships between laboratory and field exposures under static conditions. This calculation shall use the N1 term defined in annex B, section B.8.3. The N2 term shall always equal one when calculating normalized static concentrations.

For multiple-installation products, (e.g. pipes, fittings, and joining and sealing products used with pipes and fittings) the $V_{F(static)}$ component of the N1 term shall be the volume of water contained within the assumed length of pipe corresponding to the segment of the system in which the product is used (e.g., 100 ft of pipe in the service line or 280 ft of pipe in the residence).

For valves, water meters, service saddles, backflow preventers and other products not present in the system at regularly repeating intervals, the $V_{F(static)}$ component of the N1 term shall be the volume of water a product holds (on its own) when filled to capacity; $V_{F(static)}$ shall equal 1 L (0.26 gal) for all products that, when filled to capacity, hold (on their own) less than 1 L (0.26 gal) of water.

NOTE 1 – Annex B, table B9 details the assumptions and resulting N1 factors for typical product categories.

NOTE 2 – For internal threaded products, SA_F shall be equal to the normally wetted surface area of the product including 25% of the threaded area(s). The capacity of the product shall be equal to the volume of water contacted by the wetted surface area of the product including the volume contained within 25% of the threaded area(s). When the product capacity is less than 1 L (0.26 gal), $V_{F(static)}$ shall equal 1 L (0.26 gal). When the product capacity is equal to or greater than 1 L (0.26 gal), $V_{F(static)}$ shall be equal to the capacity.

B.8.3.2 Flowing conditions

In addition to the static condition, the contaminant concentration shall also be adjusted to reflect differences between laboratory and field exposures under flowing conditions. For this calculation, N2 will vary depending on use. For those products not having specific flowing N2 factors outlined in table B9, product literature or operational procedures shall be consulted.

NOTE – Annex B, table B9 details the assumptions and resulting N2 values for typical product categories.

B.8.4 Normalization of service line and residential products

B.8.4.1 For all service line and residential products, with the exception of mechanical plumbing devices covered under 9, a single normalized static concentration shall be determined for each contaminant.

NOTE – For residential and service line products, the static condition is the most conservative normalization since the N2 values for these products are ≤ 0.1.

B.8.4.2 For in-line devices, with the exception of expansion tanks and pressure tanks, the static normalized contaminant concentration shall be multiplied by an additional normalization factor, N3. The factor N3 = 1/DF, where DF is equal to the ratio of the contaminant concentration in the device to the contaminant concentration at the tap. The value of N3 for in-line devices shall be 0.33

B.8.4.3 For all in-line devices, normalized contaminant concentrations shall be adjusted to a 12 h exposure when the final exposure is other than 12 h in length

NOTE – For example, when the final exposure for an in-line device is 16 h, the normalized contaminant concentrations shall be multiplied by a factor of $^{12}/_{16}$.

B.8.5 Normalization for chemical feeders and generators

Chemical feeders and generators, feeder components, and the materials used therein, present a special case because the materials are in contact with a concentrated chemical, which is then diluted at the prescribed feed rate, rather than in direct contact with water.

In addition to the equation in annex B, section B.8.3, the following normalization factor shall be used to estimate the normalized concentration of a contaminant in the finished drinking water:

$$NF = N1 \times N2 \times N4$$

where.

$$N4 = V_{TC}/V_{WT}$$

V_{TC} = volume of concentrated treatment chemical contacted or generated by the device during a period of time equivalent to the laboratory test

V_{WT} = volume of raw water treated with the concentrated chemical when dosed at the prescribed feed rate during a period of time equivalent to the laboratory test

B.8.6 Normalization for other products

The normalization factors described below shall be applied to products and materials not covered in annex B, sections B.8.4 and B.8.5. For these products, a single normalized concentration (either static condition or flowing condition, whichever is most conservative) shall be determined for each contaminant. For products that have a flowing N2 value ≤ 0.1, the static condition shall be the most conservative condition. For products that have a flowing N2 value > 0.1, the flowing condition shall be the most conservative condition. Normalization factors that are not included in annex B, table B9 shall be determined on a case-by-case basis using the equation in annex B, section B.8.3. Where a product is available in various sizes, the product with the highest surface area-to-volume ratio (typically the smallest diameter) shall be evaluated. For products, components, or materials that may be used in any of the 4 end use categories in annex B, table B9, qualifying by use of the largest normalization factor shall qualify other use categories. Table B9 in this annex details the assumptions and resulting N1 and N2 values for various product categories.

B.8.7 Normalized concentration

The concentration of a contaminant in the finished drinking water shall be estimated using the following calculation:

Normalized Concentration = (Laboratory Concentration) x (Normalization Factor)

B.8.7.1 Static condition

The normalized contaminant concentration under static conditions shall be compared to the EPA MCL or the calculated TAC (as specified in annex A), and shall be less than or equal to the MCL or TAC.

B.8.7.2 Flowing condition

The normalized contaminant concentration under flowing conditions shall be compared to the Single Product Allowable Concentration (SPAC) (as specified in annex A), and shall be less than or equal to the SPAC.

B.8.7.3 Barrier materials containing solvents

Products/materials containing solvents shall be exposed such that the solvent leaching rates over time are determined. The relationship between normalized contaminant concentrations and time shall be determined

and plotted with a minimum of five points. The normalized contaminant concentrations shall be compared to the STEL as specified in annex A, section A.5.

B.8.7.4 Joining and sealing materials containing solvents

The manufacturer shall have the option to initiate additional exposure testing to determine contaminant concentrations over time for solvent-containing materials. The relationship between contaminant concentrations and time shall be determined, and plotted with a minimum of 5 points. The normalized contaminant concentrations shall be calculated and then compared to the STEL as specified in annex A, section A.5.

B.8.8 Normalization for endpoint devices, components, and materials

B.8.8.1 Normalization for lead

For endpoint products, other than commercial kitchen products, each laboratory concentration shall be normalized using the equation in annex B, section B.8.3 where: $V_{F(static)}$ = 1 L (0.26 gal) and N2 = 1, and shall be multiplied by the cold mix volume adjustment factor (see 9.2.1)

For commercial kitchen products, each laboratory concentration shall be normalized using the equation in annex B, section B.8.3 where $V_{F(static)}$ = 18.9 L (5 gal) and N2 = 1 and shall be multiplied by the CMV adjustment factor (see 9.2.1).

A parametric data evaluation (annex B, section B.8.9) shall be used to evaluate the test results for lead.

When a device or component has been tested for lead through separate exposure of two or more components or materials, the values of the test statistic Q for each exposure shall be summed. The summed test statistic Q shall be evaluated against the criteria in annex B, section B.8.9.

B.8.8.2 Normalization for all analytes except lead

For endpoint products other than commercial kitchen products, the laboratory concentration shall be normalized using the equation in annex B, section B.8.3 where: $V_{F(static)}$ = 1 L (0.26 gal) and N2 = 1, and shall be multiplied by the CMV adjustment factor (see 9.2.1).

For commercial kitchen products, each laboratory concentration shall be normalized with the equation in annex B, section B.8.3 where: $V_{F(static)}$ = 18.9 L (5 gal) and N2 = 1, and shall be multiplied by the CMV adjustment factor (see 9.2.1).

When one sample is tested, the normalized contaminant concentrations from exposure on Day 19 shall be compared to their respective SPACs. If more than one sample is tested, the geometric mean of normalized contaminant concentrations from exposure at Day 19 shall be compared to their respective SPACs.

B.8.9 Parametric data evaluation

The term "product" connotes "endpoint devices, components, and materials." This procedure is based on testing a sampling of products to determine the lead leaching concentrations of the product line. A derived test statistic determines whether the product line is acceptable under this standard. The calculations assume that the lead dosage leached from the product is lognormally distributed.

The number of products to be tested shall be specified by the manufacturer, though a minimum of 3 is required. It is recommended that product lines thought to be marginally acceptable (those that leach higher, but acceptable, dosages of lead) should be tested for more than the minimum number of products. For each of the products tested, the "product dosage" D_i is derived from the test data as detailed in annex B, section B.8.9.2. These dosages are used to calculate the test statistic Q, which determines whether the product line is acceptable. Q is an exact 90% upper confidence bound on the 75th percentile product dosage.

In the event of a product failure, there is provision for a single retest. Retest results shall be combined with those from the initial test. The accumulated product dosages shall be used to calculate the retest statistic, R, which determines whether the product line is acceptable. R is an exact 99% upper confidence bound on the 75th percentile product dosage.

B.8.9.1 Test data

The analytical protocol described in annex B, section B.5.4 generates nine measured lead dosages (on Days 3, 4, 5, 10, 11, 12, 17, 18, and 19) leached from each of the products sampled from a particular product line. The number of products tested is defined as "n." The test data are described as (9 x n) data values of x_{ij} (ith product measured on the jth day) and are shown in annex B, table B12. These are used to calculate the product dosage D_i, for each of the tested products.

These data are used to calculate the statistics Q and R for the initial test and retest, respectively.

B.8.9.2 Calculations

$$D_i = e^{Y_i}$$

and

$$Y_i = \frac{(Y_{i3} + Y_{i4} + Y_{i5} + Y_{i10} + Y_{i11} + Y_{i12} + Y_{i17} + Y_{i18} + Y_{i19})}{9}$$

Calculate the log-dosage mean of Y_i and the log-dosage standard deviation of Y_i for each product, where:

$$\text{Log - dosage mean} = \overline{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}$$

and

Log-dosage standard deviation =

$$S = \sqrt{\frac{\sum_{i=1}^{n} (Y_i - \overline{Y})^2}{(n-1)}}$$

B.8.9.3 Initial test statistic

The test statistic, Q shall be determined as:

$$Q = e^{\overline{Y}} \cdot e^{k_1 \cdot S}$$

where the log-dosage mean, $\overline{Y}$ and the log-dosage standard deviation, S, are determined using the procedures described in annex B, section B.8.9.2. The value of k_1 depends upon the sample size. Table B11 in this annex presents the value of k_1 for a range of sample sizes. The acceptability of the product line depends upon the value of the test statistic, where:

- Case I: If Q ≤ 11 µg, the product line has tested as acceptable; or
- Case II: If Q > 11 µg, the product line has tested as unacceptable

When a device or component has been tested for lead through separate exposure of two or more components or materials, the summed value of the test statistic Q shall be compared to the preceding criteria

B.8.9.4 Retest statistic

The retest statistic, R shall be determined as:

$$R = e^{\overline{Y}} \cdot e^{k_2 S}$$

where the log-dosage mean, $\overline{Y}$ and the log-dosage standard deviation, S are determined using the procedures described in annex B, section B.8.9.2. The value of k_2 depends upon the sample size. Annex B, table B12 presents the value of k_2 for a range of sample sizes. The acceptability of the product line depends upon the values of the retest statistic, where:

- Case I: If R ≤ 11 µg, the product line has tested as acceptable; or
- Case II: If R > 11 µg, the product line has tested as unacceptable.

B.9 Extraction water preparation

B.9.1 Chemical characteristics

Four extraction waters shall be available for exposure:

a) pH = 5, with 2 mg/L available chlorine and 100 mg/L hardness;
b) pH = 6.5, with 2 mg/L available chlorine and 100 mg/L hardness;
c) pH = 8 (organic analysis), with 0 mg/L available chlorine and 100 mg/L hardness; and
d) pH = 10, with 2 mg/L available chlorine.

B.9.2 Reagents

B.9.2.1 Reagent water

Reagent water shall be produced through one or more of the following treatment processes: distillation, reverse osmosis, ion exchange, or other equivalent treatment processes. The reagent water shall have the following general water characteristics:

- electrical resistivity, minimum 18 MΩ-cm at 25° C (77 °F); and
- total organic carbon (TOC) maximum 100 µg/L.

For each specific analyte of interest, the reagent water shall not contain the target analyte at a concentration greater than one-half the designated analytical report limit of that analyte.

B.9.2.2 Phosphate buffer stock solutions (0.1M)

Dissolve 13.89 g sodium dihydrogen phosphate monohydrate in reagent water, dilute to 1.0 L (0.26 gal) and mix thoroughly. Prepare fresh weekly. This buffer shall be used with only the magnesium hardness reagent.

B.9.2.3 Magnesium hardness stock solution (0.04M)

Dissolve 8.13 g magnesium chloride hexahydrate in reagent water, dilute to 1.0 L (0.26 gal), mix thoroughly. Prepare fresh weekly.

B.9.2.4 Chlorine stock solution (0.025M)

Dilute 7.3 mL reagent grade sodium hypochlorite (5% NaOCl) to 200 mL with reagent water. Store in tightly stoppered amber reagent bottle protected from light and stored at 20 °C (68 °F). Prepare fresh weekly.

B.9.2.4.1 Determining chlorine stock solution strength

Determine the strength of the chlorine stock solution by diluting 1.0 mL to 1.0 L (0.26 gal) with reagent water. Immediately analyze for total residual chlorine. Refer to this determination as "A."

B.9.2.4.2 Determining amount of chlorine stock solution required to obtain 2 ppm residual chlorine
To determine the volume of the chlorine stock solution necessary to add to the extraction water to obtain 2.0 mg/L chlorine residual, use the following formula:

$$\text{mL stock solution} = \frac{2.0 \times B}{A}$$

where:

A = chlorine equivalent per mL of chlorine stock solution (determined above); and
B = liters of extraction water.

B.9.2.5 Calcium hardness stock solution (0.04M)

Dissolve 4.44 g anhydrous calcium chloride in reagent water, dilute to 1.0 L (0.26 gal), mix thoroughly. Prepare fresh weekly.

B.9.2.6 Sodium bicarbonate buffer (0.04M)

Dissolve 3.36 g sodium bicarbonate in reagent water and dilute to 1.0 L (0.26 gal) mixing thoroughly. Prepare fresh weekly.

B.9.2.7 Sodium hydroxide solution (0.1M)

Dissolve 4.0 g of sodium hydroxide in reagent water, dilute to 1.0 L (0.26 gal) and mix well.

B.9.2.8 Sodium borate solution (0.05M)

Dissolve 19.07 g of sodium borate decahydrate ($Na_2B_4O_7$ 10 H_2O) in reagent water, dilute to 1.0 L (0.26 gal) and mix well.

B.9.3 pH 5 water

Prepare pH 5 extraction water to contain 100 mg/L hardness and 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in annex B, table B15, shall be diluted to the desired water volume with reagent water.

B.9.4 pH 6.5 water

Prepare pH 6 5 water to contain 100 mg/L hardness and 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in annex B, table B15 shall be diluted to the desired water volume with reagent water. The pH shall be adjusted to pH 6.5 ± 0.5 using 0.1M HCl.

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NOTE – It is recommended that the pH 6.5 water be protected from exposure to air during its formulation and use to minimize pH drift. Unused exposure water should be maintained under a nitrogen blanket, and product samples should be plugged or tightly covered to minimize exposure to air.

B.9.5 pH 8 water (conditioning)

Prepare pH 8 conditioning water to contain 100 mg/L hardness and 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in annex B, table B15, shall be diluted to the desired water volume with reagent water.

B.9.6 pH 8 water (organic analysis)

Prepare pH 8 organic extraction water to contain 100 mg/L hardness and 0 mg/L available chlorine. Stock reagent solutions in the amounts shown in annex B, table B15 should be diluted to the desired water volume with reagent water.

B.9.7 pH 10 water

Prepare pH 10 extraction water to contain 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in annex B, table B15, shall be diluted to the desired water volume with reagent water.

	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
Test Day				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
						C	C	C					C	C	C					C	C	C
	W/C			2	2	2	2	2			2	2	2	2	2			2	2	2	2	
				2	2	2	2	2			2	2	2	2	2			2	2	2	2	
				2	2	2	2	2			2	2	2	2	2			2	2	2	2	
				2	2	2	2	2			2	2	2	2	2			2	2	2	2	
	< 72			16	16	16	16	64			16	16	16	16	64			16	16	16	16	

Key

W/C = washing and conditioning
< 72 = dwell between conditioning and exposure sequence (Maximum: 72 h)
2 = dump and fill 2 h intervals
16 = 16 h dwell (overnight)
16 = 16 h dwell for data
C = collect prior day's 16 h dwell
64 = 64 h dwell (weekend)

Figure B1 – Exposure sequence for mechanical plumbing device

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Table B1 – NSF/ANSI 61 products

Joining and sealing materials	Mechanical devices

adhesives
brazing materials
  fluxes
  solders
caulks
gaskets
grouts
lubricants
o-rings
packing
primers
sealants
	chemical feeders
	  dry feeders (e g pellet droppers)
	  pressure gas injection systems
	  pumps
	  vacuum injection systems
	disinfection/generators
	  chlorine dioxide
	  hypochlorite
	  ozone
	  ultraviolet
	electrical wire
	  submersible well pumps
	pumps
	switches and sensors (e.g. water level, flow, pressure, temperature)
	valves and related fittings (transmission/distribution system)
	water process treatment devices
	  aeration equipment
	  clarifiers
	  electrodialysis
	  microfiltration
	  mixers
	  reverse osmosis
	  screens
	  strainers
	  ultrafiltration

Table B2 – Exposure summary

Category	Annex B reference section	Type of samples (surface area)	Required preparation	Product exposure
joining and sealing materials	4	15 cm^2/L	Some products applied to an appropriate substrate. Some products cut to appropriate size. Washed to remove debris accumulated during shipping and handling.	cold exposure = 24, 24, 24 h at 23 °C (73 °F) hot exposure = 1, 1, 1 h at 82 °C (180 °F)
mechanical devices	5	entire device, component, or material specimen[1]	Wash to remove debris accumulated during shipping.	conditioning period prior to exposure (2 weeks maximum) cold exposure = 24, 24, 24 h at 23 °C (73 °F)

[1] A material specimen shall be exposed using a minimum surface area-to-volume ratio or 50 cm^2/L.

Table B3 – Extraction water selection

Analytes of interest	pH		
	5	8	10
metals	X	•	X
solvents	•	X	•
volatile organic chemicals	•	X	•

KEY
X = Preferred extraction water selection
• = Alternate extraction water(s) if indicated by formulation review.

NOTE – Solvents = The organic liquid component of a formulation used to dissolve solid or other liquid components of barrier materials or joining and sealing materials to facilitate their application.

Table B4 – Test samples joining and sealing materials

Material	Typical form
adhesives and cements intended for joining pipe and fittings	applied to assembled pipe and fitting joints
adhesives and cements not intended for joining pipe and fittings	applied to glass panels
caulks, greases, lubricants, sealants	applied to glass panels
flux	applied to copper sheet and heated
gasket materials	ASTM D3182 tensile sheets or finished product
solders and solder/flux combinations	product heated in ceramic combustion boats

Table B5 – Exposure sequence for cold applications

Exposure temperature	Exposure time	Elapsed time	Comment
23 ± 1 °C (73 ± 2 °F)	24 ± 1 h	1 d	Extraction water is decanted and discarded; the exposure vessel or product is refilled with exposure water and exposure is continued.
23 ± 1 °C (73 ± 2 °F)	24 ± 1 h	2 d	Extraction water is decanted and discarded; the exposure vessel or product is refilled with exposure water and exposure is continued.
23 ± 1 °C (73 ± 2 °F)	24 ± 1 h	3 d	Extraction water is collected for analysis

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Table B6 – Exposure sequence for hot applications

Exposure temperature	Exposure time	Elapsed time	Comment
60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F)	60 ± 5 min	1 h	Extraction water is decanted and discarded; the exposure vessel or product is refilled with exposure water and exposure is continued.
60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F)	60 ± 5 min	2 h	Extraction water is decanted and discarded; the exposure vessel or product is refilled with exposure water and exposure is continued.
60 ± 1 °C (140 ± 2 °F) or 82 ± 1 °C (180 ± 2 °F)	60 ± 5 min	3 h	Extraction water is collected for analysis.

Table B7 – Product exposure[1]

Product	In-the-product	In-a-vessel	Other
aeration equipment	x		material exposed in a vessel
chemical feeders	x		material exposed in a vessel
clarifiers			material exposed in a vessel
disinfection equipment			material exposed in a vessel
electrical wire		x	
in-line devices	x		
membranes/cartridges	x		
mixers			materials exposed in a vessel
pumps	x		
reverse osmosis			
screens		x	
strainers	x		
switches/sensors	x		
valves	x		

[1] For the purposes of this table, product may represent either the entire device or a component. These are the typical exposure conditions. However, products may be exposed in any fashion provided the exposure is consistent with requirements in annex B, section B.2.

Table B8 – In-line device exposure sequence

Temperature	In-line device exposure time	Elapsed time[1] in-line devices
23 ± 2 °C (73 ± 4 °F)	24 h	24 h
23 ± 2 °C (73 ± 4 °F)	24 h	48 h
23 ± 2 °C (73 ± 4 °F)	12 to 16 h	60 to 64 h

[1] Elapsed time does not include the initial 14-d conditioning period.

Table B9 – Other mechanical device exposure sequence

Temperature	Exposure time other mechanical devices	Elapsed time other mechanical devices
23 ± 2°C (73 ± 4°F)	24 h	24 h
23 ± 2°C (73 ± 4°F)	24 h	48 h
23 ± 2°C (73 ± 4°F)	24 h	72 h

[1] Elapsed time does not include the initial 14-day conditioning period.

Table B10 – Extractant water collection and preservation

Contaminant	Preservative	Container	Storage
herbicide	none	1 L (32 ounce) amberglass bottles with PTFE lid	4 °C (39 °F)
metals, including mercury	Conc. HNO_3 to pH < 2 (1.25 mL)	125 mL (4 ounce) HDPE bottles with PTFE lid	room temp.
miscellaneous organics	none	500 mL amber bottle with PTFE lid	4 °C (39 °F)
pesticides	none	500 mL (16 ounce) amber glass bottle with PTFE lid	4 °C (39 °F)
phenols	H_2SO_4 to pH < 2 (2.50 mL)	250 mL (8 ounce) amber glass bottle with PTFE lid	4 °C (39 °F)
phthalate	none	1 L glass bottle with PTFE lid (in duplicate)	4 °C (39 °F)
polyaromatic hydrocarbon	none	1 L glass bottle (in duplicate)	4 °C (39 °F)
radionuclides	10.0 mL HNO_3	1 L (32 ounce) polyethylene bottle (in duplicate)	room temp.
solvents	none	125 mL (4 ounce) amber bottle with PTFE lid	4 °C (39 °F)
total kjeldahl nitrogen	H_2SO_4 to pH < 2	250 mL amber bottle with PTFE lid	4 °C (39 °F)
total organic carbon	none	250 mL amber bottle with PTFE lid	4 °C (39 °F)
non-section 9 exposure for volatile organic chemicals (VOCs)	HCl	40 mL amber glass vial with PTFE lid	4 °C (39 °F)
section 9 exposure for volatile organic chemicals (VOCs)	sodium thiosulfate (a few grains to neutralize the chlorine)	40 mL amber glass vial with PTFE lid	4 °C (39 °F)

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Table B11 – Normalization factors, assumptions, and examples pertaining to – *water main joining and sealing materials*

Product nominal diameter (n.d.)	Exposure type	Probable end use[a)]	Assumptions	N1	N2 (flowing normalization only)
n d. > 4 in	in-the-vessel	water main	– water is exposed to the same material from the treatment plant to the service line.	calculated in accordance with annex B, section B.8.3	1

EXAMPLE-- IN-THE-VESSEL WATER MAIN JOINING AND SEALING MATERIAL:

Assumptions.

- product is a joining and sealing material applied to a 6 in nominal diameter pipe and was exposed in a vessel;
- 0.5 in joining and sealing material width is exposed to water;
- 20 ft long pipe (used to derive $V_{F(static)}$ and SA_F) and 1 joint per 20 ft length; and
- the ratio of SA_L to V_L was recorded and reported by the laboratory.

SA_F = 60.77 cm^2 (9.42 in^2) SA_L = 15 cm^2 (2.3 in^2)
$V_{F(static)}$ = 111 L (29.3 gal) V_L = 1 L (0 26 gal)

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}} = \frac{9.42}{2.33} \times \frac{0.26}{29.4} = 0.036 \text{ and } N2=1$$

Comments:

- Concentrations reported by the laboratory would be multiplied by 0.036 to obtain a normalized static concentration. The resulting normalized static concentration would be multiplied by 1 (N2 = 1) to obtain the normalized flowing concentration.

[a)] Probable end use and corresponding assumptions are related to the nominal diameter of the product.

Table B11 (cont.) – Normalization factors, assumptions, and examples pertaining to – multiple user service line joining and sealing materials

Product nominal diameter (n.d.)	Exposure type	Probable end use[a)]	Assumptions	N1	N2 (flowing normalizations only)
n.d. = 4 in	in-the-vessel	multiple user service line	– 2 user connections per service line and 180 gal/d/user – distance from water main to residential connections = 72 ft and therefore $V_{F(static)}$ = 47 gal; flow rate equals 360 gal/d and therefore $V_{F(flow)}$ = 360 gal – 5 joints per multiple user service line	calculated in accordance with annex B, section B.8.3	0.13

EXAMPLE-- IN-THE-VESSEL MULTIPLE USER SERVICE LINE JOINING AND SEALING MATERIALS:

Assumptions:

- product is a joining and sealing material applied to a 4 in nominal diameter pipe and was exposed in a vessel;
- 0.5 in joining and sealing material width is exposed to water;
- 5 joints per multiple user service line;
- 72 ft of the pipe is present in the multiple user service line and therefore $V_{F(static)}$ = 47 gal (178 L); and
- the ratio of SA_L to V_L was recorded and reported by the laboratory.

SA_F = 40.6 cm^2 (6.3 in^2) x 5 = 202.6 cm^2 (31 4 in^2) SA_L = 15 cm^2 (2.3 in^2)
$V_{F(static)}$ = 178 L (47 gal) V_L = 1 L (0.26 gal)

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}} = \frac{31.4}{2\ 33} \times \frac{0.26}{47} = 0\ 076$$

$$N2 = \frac{V_{F(static)}}{V_{F(flow)}} = \frac{47}{360} = 0.13$$

Comments:

- Concentrations reported by the laboratory would be multiplied by 0 076 to obtain a normalized static concentration. The resulting normalized static concentration would be multiplied by 0.13 to obtain the normalized flowing concentration.

[a)] Probable end use and corresponding assumptions are related to the nominal diameter of the product.

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Table B11 (cont.) – Normalization factors, assumptions, and examples pertaining to – *service line joining and sealing materials*

Product nominal diameter (n.d.)	Exposure type	Probable end use[a)]	Assumptions	N1	N2 (flowing normalization only)
4 in > n.d. > 1 in	in-the-vessel	service line	– joining/sealing materials applied to 1 in nominal diameter pipe – 1 user connection per service line and 180 gal/d/user – distance from water main to residence = 100 ft and therefore $V_{fc)}$ = 4.08 gal – flow rate equals 180 gal/d and therefore $V_{F(flow)}$=180 gal – 10 joints are present on the service line	calculated in accordance with annex B, section B.8.3	0.023

EXAMPLE --IN-THE-VESSEL SERVICE LINE JOINING AND SEALING MATERIALS:

Assumptions:

- an in-the-vessel exposure was conducted;
- product is used to join 1 in nominal diameter pipe;
- 0.5 in width of the joining and sealing material comes in direct contact with water;
- 100 ft of the pipe is present in the service line and therefore $V_{F(static)}$ = 4.08 gal;
- 10 joints are present on the service line; and
- the ratio of SA_L to V_L was recorded and reported by the laboratory.

SA_F = 10.1 cm^2 (1.57 in^2) x 10 = 101.3 cm^2 (15.7 in^2) SA_L= 15 cm^2 (2.3 in^2)
$V_{F(static)}$ = 15.44 L (4.08 gal) V_L = 1 L (0.26 gal)

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}} = \frac{15.7}{2.3} \times \frac{0.26}{4.08} = 0.44$$

$$N2 = \frac{V_{F(static)}}{V_{F(flow)}} = \frac{4.08}{180} = 0.023$$

Comments:

- Concentrations reported by the laboratory would be multiplied by 0.44 to obtain a normalized static concentration. The resulting normalized static concentration would be multiplied by 0.023 to obtain the normalized flowing concentration.

[a)] Probable end use and corresponding assumptions are related to the nominal diameter of the product.

Table B11 (cont.) – Normalization factors, assumptions, and examples pertaining to – *residential joining and sealing materials*

Product nominal diameter (n.d.)	Exposure type	Probable end use[a)]	Assumptions	N1	N2 (flowing normalization only)
1 in > n.d. ≥ 0.5 in	in-the-vessel	residential	– joining/sealing materials applied to 0.5 in nominal diameter pipe – length of pipe in the residence = 280 ft (140 ft cold side and 140 ft hot side) and therefore $V_{F(static)}$=2.86 gal (1.43 gal hot and 1.43 gal cold) – flow rate equals 180 gal/d and therefore $V_{F(flow)}$ = 180 gal – 200 joints are present in the residential system	calculated in accordance with annex B, section B.8.3	0.016

EXAMPLE--IN-THE-VESSEL RESIDENTIAL JOINING AND SEALING MATERIAL

Assumptions:

- an in-the-vessel exposure was conducted;
- product is a joining and sealing material used to join 2 in nominal diameter pipe,
- 0.25 in width of the joining and sealing material comes in direct contact with water;
- 280 ft of pipe is present in the residence (used to derive $V_{F(static)}$ and SA_F);
- the ratio of SA_L to V_L was recorded and reported by the laboratory; and
- 200 joints are present in the residential system

$SA_F = 2.54\ cm^2\ (0.393\ in^2) \times 200 = 507\ cm^2\ (78.6\ in^2)$ $\quad SA_L = 65\ cm^2\ (10\ in^2)$

$V_{F(static)} = 10.83\ L\ (2.86\ gal)$ $\quad V_L = 1\ L\ (0.26\ gal)$

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}} = \frac{78.6}{10} \times \frac{0.26}{2.86} = 0.73$$

$$N2 = \frac{V_{F(static)}}{V_{F(flow)}} = \frac{2.86}{180} = 0.016$$

Comments:

- Concentrations reported by the laboratory would be multiplied by 0.73 to obtain a normalized static concentration. The resulting normalized static concentration would be multiplied by 0.016 to obtain the normalized flowing concentration

[a)] Probable end use and corresponding assumptions are related to the nominal diameter of the product.

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Table B11 (cont.) – Normalization factors, assumptions, and examples pertaining to – *water main valves*

Product nominal diameter (n.d.)	Exposure type	Probable end use[a)]	Assumptions	N1	N2 (flowing normalization only)
n.d. ≥ 4 in	in-the-product	water main	– twenty 4 in valves per mile (5,280 ft) – a width of 6 in is exposed for each valve	1	0.002

EXAMPLE -- IN-THE-PRODUCT WATER MAIN VALVE:

Assumptions:

- product is a 4 in nominal diameter valve used on pipe having an nominal diameter of 4 in;
- an in-the-product exposure was conducted; and
- for each valve, a width of 6 in comes in direct contact with water.

$SA_F = 484\ cm^2\ (75\ in^2)$ $\qquad$ $SA_L = 484\ cm^2\ (75\ in^2)$

$V_{F(static)} = 1.24\ L\ (0.327\ gal)$ $\qquad$ $V_L = 1.24\ L\ (0.327\ gal)$

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}} = \frac{75}{75} \times \frac{0.327}{0.327} = 1$$

$$N2 = \frac{\text{volume of 20 valves}}{\text{volume of 1 mile of pipe}} = \frac{6.52}{3{,}447} = 0.002$$

Comments:

- Laboratory concentrations would be multiplied by 0.002 and compared to the SPAC.

[a)] Probable end use and corresponding assumptions are related to the nominal diameter of the product.

Table B11 (cont.) – Normalization factors, assumptions, and examples pertaining to – *residential and service line valves (including multiple user)*

Product nominal diameter (n.d.)	Exposure type	Probable end use[a)]	Assumptions	N1	N2 (flowing normalization only)	N3
4 in > n d. ≥ 0.5 in	in-the-product	service line or residential	– when product holds less than 1 L (0.26 gal) under static conditions, $V_{F(static)}$ = 1 L = 0 26 gal – $V_{F(flow)}$=180 gallons	calculated in accordance with annex B, section B.8 3	0.0015	0.33

EXAMPLE-- IN-THE-PRODUCT SERVICE LINE VALVE:

Assumptions:

- product is a 0.5 in nominal diameter valve having a length of 2 in;
- an in-the-product exposure was conducted; and
- $V_{F(static)}$=1 L because the valve holds less than 1 L of water when filled to capacity under static conditions.

SA_F = 20.26 cm^2 (3.14 in^2) SA_L = 20.26 cm^2 (3.14 in^2)
$V_{F(static)}$ = 1 L (0.26 gal) V_L = 0.0064 L (0.0017 gal)

$$N1 = \frac{SA_F}{SA_L} \times \frac{V_L}{V_{F(static)}} \text{ x dispersion factor (N3)} = \frac{3.14}{3.14} \times \frac{0.0017}{0.26} \times 0.33 = 0.0021$$

$$N2 = \frac{V_{F(static)}}{V_{F(flow)}} = \frac{0.26}{180} = 0.0015$$

Comments.

- Laboratory concentrations would be multiplied by 0.0021 to obtain the normalized static concentration. The resulting normalized static concentration would be multiplied by 0.0015 to obtain the normalized flowing concentration.

[a] Probable end use and corresponding assumptions are related to the nominal diameter of the product.

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Table B12 – Data available for determination of lead test statistic

Product#	Measured lead dosage on day								
	3	4	5	10	11	12	17	18	19
1	$X_{1\,3}$	$X_{1\,4}$	$X_{1\,5}$	$X_{1\,10}$	$X_{1\,11}$	$X_{1\,12}$	$X_{1\,17}$	$X_{1\,18}$	$X_{1\,19}$
2	$X_{2\,3}$	$X_{2\,4}$	$X_{2\,5}$	$X_{2\,10}$	$X_{2\,11}$	$X_{2\,12}$	$X_{2\,17}$	$X_{2\,18}$	$X_{2\,19}$
3	$X_{3\,3}$	$X_{3\,4}$	$X_{3\,5}$	$X_{3\,10}$	$X_{3\,11}$	$X_{3\,12}$	$X_{3\,17}$	$X_{3\,18}$	$X_{3\,19}$
•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•
n	$X_{n\,3}$	$X_{n\,4}$	$X_{n\,5}$	$X_{n\,10}$	$X_{n\,11}$	$X_{n\,12}$	$X_{n\,17}$	$X_{n\,18}$	$X_{n\,19}$

Table B13 – Values of k_1 for determining test statistic Q

Sample size	k_1	Sample size	k_1	Sample size	k_1
3	2.60281	19	1.05769	35	0 94208
4	1.97224	20	1.04590	36	0.93783
5	1.69779	21	1.03510	37	0.93377
6	1.53987	22	1.02517	38	0.92990
7	1.43526	23	1.01598	39	0.92618
8	1.35984	24	1.00747	40	0.92262
9	1.30234	25	0.99954	41	0.91921
10	1.25672	26	0.99213	42	0.91592
11	1.21943	27	0.98520	43	0.91277
12	1.18824	28	0.97869	44	0.90973
13	1.16167	29	0.97256	45	0.90680
14	1.13870	30	0.96677	46	0.90397
15	1 11859	31	0.96130	47	0.90125
16	1 10080	32	0 95612	48	0.89861
17	1 08491	33	0 95120	49	0.89607
18	1 07063	34	0.94653	50	0.89361

Table B14 – Values of k_2 for determining retest statistic R

Sample size	k_2	Sample size	k_2	Sample size	k_2
6	2.84809	21	1 39862	36	1.18574
7	2.49072	22	1.37611	37	1.17721
8	2.25337	23	1.35548	38	1 16907
9	2.08314	24	1.33647	39	1.16130
10	1.95433	25	1.31889	40	1.15387
11	1.85297	26	1.30257	41	1.14676
12	1.77079	27	1.28738	42	1.13994
13	1.70259	28	1 27319	43	1.13340
14	1.64491	29	1.25989	44	1.12711
15	1.59536	30	1.24740	45	1.12107
16	1.55224	31	1.23565	46	1 11526
17	1.51431	32	1.22455	47	1.10966
18	1.48063	33	1.21407	48	1.10425
19	1.45048	34	1.20413	49	1.09904
20	1.42329	35	1 19470	50	1.09401

Table B15 – One-liter volume of extraction water

pH	Solution #1	Solution #2	Chlorine stock solution
5	25 mL of 0 1 M NaH_2PO_4	25 mL of 0 04 M $MgCl_2$	annex B, section B 9.2 4
6.5	25 mL of 0.04 M $NaHCO_3$	25 mL of 0.04 M $CaCl_2$	annex B, section B.9.2.4
8 (conditioning)	25 mL of 0.04 M $NaHCO_3$	25 mL of 0.04 M $CaCl_2$	annex B, section B.9.2.4
8 (organic)	25 mL of 0.04 M $NaHCO_3$	25 mL of 0.04 M $CaCl_2$	none
10	50 mL of 0.1 M NaOH	50 mL of 0.05 M $Na_2B_4O_7$	annex B, section B.9.2.4

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Annex C
(normative)

Acceptable materials

C.1 Purpose

This annex defines the evaluation process for materials that have been submitted for qualification as acceptable materials

C.2 Evaluation of acceptable materials

A material that has a standard material formulation or specification (e.g. ASTM), has undergone extraction testing that demonstrates that the material does not contribute any contaminant in excess of its acceptable level as determined by this Standard (see annex C, section C.3), and is accompanied by adequate documentation (section 3.4.2), shall be designated as an "acceptable material" in table C1.

C.3 Extraction testing

Thirty randomly selected samples from a variety of manufacturers of the material, in a specific form (e.g., pipe or tube), shall undergo extraction testing All of the samples shall have been manufactured using the same production process Selection of analytical testing shall be performed in accordance with 3.3. The samples shall be exposed at the maximum surface area to volume ratio for which acceptance is being sought. Depending on the specific form of the material, the samples shall be evaluated with the extraction protocol, normalization formulas and assumptions, and evaluation criteria contained in the applicable sections of this Standard.

C.4 Documentation

The material's evaluation shall be supported by the following documentation:

- the published material formulation or specification to which the material is fabricated;

- literature that comprehensively addresses the production process, raw material sources, and all other factors that could potentially affect the composition and variability of the material; and

- information and data that summarize the results from the laboratory extraction of the 30 randomly selected samples, including data from a detection limit study, quality control data run concurrently with the samples, a description of the methods and instrumentation used, and a verification that the laboratory in which the extraction testing was conducted is certified for drinking water analysis by the regulatory agency having authority.

A final report that outlines the manner in which these requirements have been met shall be prepared.

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Table C1 – Acceptable materials

Material	Specific designation	Standard (product) reference	Surface area-to-volume ratio	End use temperature	Composition
stainless steel	UNS S30400 (Type 304)	ASTM A 312 ASTM A 269	3,484 cm^2/L (540 in^2/L)	30 °C (86°F)	percent composition: carbon (0.08 max.), manganese (2.00 max.), phosphorus (0.040 max.), sulfur (0.030 max.), silicon (0.75 max.), nickel (8.00-11.0), chromium (18.0-20.0), iron (balance)
stainless steel	UNS S30403 (Type 304L)	ASTM A 312 ASTM A 269	3,484 cm^2/L (540 in^2/L)	30 °C (86 °F)	percent composition: carbon (0.035 max.), manganese (2.00 max.), phosphorus (0.040 max.), sulfur (0.030 max.), silicon (0.75 max.), nickel (8.00-13.0), chromium (18.0-20.0), iron (balance)
stainless steel	UNS S31600 (Type 316)	ASTM A 312 ASTM A 269	3,484 cm^2/L (540 in^2/L)	30 °C (86 °F)	percent composition: carbon (0.08 max.), manganese (2.00 max.), phosphorus (0.040 max.), sulfur (0.030 max.), silicon (0.75 max.), nickel (11.00-14.0), chromium (16.0-18.0), molybdenum (2.0-3.0), iron (balance)
stainless steel	UNS S31603 (Type 316L)	ASTM A 312 ASTM A 269	3,484 cm^2/L (540 in^2/L)	30 °C (86 °F)	percent composition: carbon (0.035 max.), manganese (2.00 max.), phosphorus (0.040 max.), sulfur (0.030 max.), silicon (0.75 max.), nickel (10.0-15.0), chromium (16.0-18.0), molybdenum (2.0-3.0), iron (balance)

Annex D
(normative)

Normative drinking water criteria

D.1 General

The drinking water criteria in this annex shall be used as normative evaluation criteria for the determination of product compliance with the health effects requirements of this Standard. The values in these tables include the consensus USEPA and Health Canada drinking water criteria for contaminants evaluated by these two agencies. They also include criteria for non-regulated contaminants that have been developed according to the toxicity data requirements of annex A, and that have been externally peer-reviewed. Non-regulatory USEPA guidance values that have been reviewed and found to satisfy annex A toxicity data requirements are also included, as well as chemicals that have been evaluated using the threshold of evaluation approach

The drinking water criteria in this annex have not been evaluated for taste and odor considerations at the concentration limits indicated

The substances listed in annex D, tables D1, D2, D3, and D4 are not intended to encompass all of the potential analytes of interest that need to be considered when evaluating products to the requirements of this Standard. The user is cautioned that each product may have formulation dependent analytes of interest for which acceptable concentration limits have not been determined. In these cases, the user is required to develop acceptable concentration limits based on the requirements of annex A of NSF/ANSI 61 in order to determine full compliance with the Standard.

These tables are specific to NSF/ANSI 61 While the tables may be used for evaluation of impurities in drinking water treatment chemicals, the substances listed in these tables may not have been evaluated for use as direct additive drinking water treatment chemicals under NSF/ANSI 60. Use as direct additive drinking water treatment chemicals may require the consideration of different exposure parameters than those used for NSF/ANSI 61 evaluation.

D.2 USEPA and Health Canada drinking water criteria

Table D1 contains drinking water criteria for contaminants regulated by the USEPA and established by Health Canada. Values for each contaminant have been agreed upon by representatives of both agencies for the purpose of evaluating products against the health effects requirements of NSF/ANSI 61. For each substance, the values in the table represent a consensus decision regarding the selection of the most appropriate assessment upon which to base NSF/ANSI 61 evaluation.

At the time of publication, the indicated values were valid. These values are subject to change, however, and the user is encouraged to contact USEPA or Health Canada for the most current values. Some of these values have been developed using a linear multistage model to predict theoretical excess carcinogenic risk at low exposure concentrations. Where the database is sufficient and the compound mode of action can be determined, the USEPA is replacing the default linear multistage model with either a biologically based cell kinetic multistage model or a margin of exposure analysis. Cancer potency (q1*) values developed using the linear multistage model may be re-evaluated in the future.

D.3 NSF International peer-reviewed drinking water criteria

Table D2 contains drinking water criteria for unregulated substances for which NSF International has determined Total Allowable Concentrations (TAC) and Single Product Allowable Concentrations (SPAC) in accordance with annex A of this Standard. These criteria have been externally peer-reviewed

At the time of publication, the indicated values were valid. These values are subject to change, however, and the user is encouraged to contact NSF International for the most current values.

D.4 Drinking water criteria based on USEPA guidance concentrations

Table D3 contains drinking water criteria for unregulated contaminants for which the acceptable drinking water concentrations are based on USEPA guidance values, including those in the USEPA Health Advisory and Integrated Risk Information System (IRIS) databases. A relative source contribution factor has been applied to calculation of the drinking water criteria when a relative source contribution factor was not applied as part of the USEPA risk assessment. In the absence of sufficient information to determine a data-derived relative source contribution factor, a default 20% drinking water contribution is assumed

At the time of publication, the indicated values were valid These values are subject to change, however, and the user is encouraged to contact USEPA for the most current values Some of these values have been developed using a linear multistage model to predict risk at low exposure concentrations and may be re-evaluated in the future

D.5 Threshold of evaluation (TOE) chemical list

Table D4 contains the list of chemicals that have been evaluated under the threshold of evaluation, due to the lack of the minimum data to determine chemical specific concentrations in accordance with the requirements of annex A (see annex A, section A 7 1) Qualification to the threshold of evaluation category includes a comprehensive literature search for the particular substance and consideration of structure-activity relationships

Table D1 – U.S. Environmental Protection Agency and Health Canada NSF/ANSI 61 drinking water criteria

Contaminant (Reference)[1]	Drinking water regulatory level (MCL/MAC) (mg/L)	Single product allowable concentration (SPAC) (mg/L)
Organics/pesticides		
alachlor (40 CFR §141.60, §141.61)	0.002	0.0002
aldicarb aldicarb sulphone aldicarb sulphoxide (40 CFR §141.60, §141.61)	0 007	0.0007
aldrin / dieldrin issue date: 10/94	0.0007	0.00007
atrazine issue date: 04/93	0.003	0.0003
atrazine and metabolites Issue date: 04/93	0.005	0.0005
azinphos-methyl Issue date: 02/86	0.02	0.002
bendiocarb Issue date: 02/86	0.04	0 004
benzene (40 CFR §141.60, §141.61)	0.005	0 0005
benzo(a)pyrene (PAH) (40 CFR §141.60, §141.61)	0 0002	0.00002
bromodichloromethane — see trihalomethanes (total)	N/A	N/A
bromoform — see trihalomethanes (total)	N/A	N/A
bromoxynil Issue date: 03/87	0.005	0.0005
carbaryl issue date: 02/86	0.09	0.009
carbofuran (40 CFR §141.60, §141.61)	0.04	0.004
carbon tetrachloride (40 CFR §141.60, §141.61)	0.005	0.0005
chlordane (40 CFR §141.60, §141.61)	0.002	0.0002
chlorodibromomethane — see trihalomethanes (total)	N/A	N/A
chloroform — see trihalomethanes (total)	N/A	N/A
chlorpyrifos issue date· 02/86	0.09	0.009
cyanazine issue date· 02/86	0.01	0.001
cyanobacterial toxin (microcystin-LR) issue date: 04/02	0.0015	0.00015
2,4-D (40 CFR §141.60, §141.61)	0.07	0.007

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Table D1 – U.S. Environmental Protection Agency and Health Canada NSF/ANSI 61 drinking water criteria

Contaminant (Reference)[1]	Drinking water regulatory level (MCL/MAC) (mg/L)	Single product allowable concentration (SPAC) (mg/L)
Organics/pesticides		
dalapon (40 CFR §141.60, §141.61)	0.2	0.02
diazinon issue date: 02/86	0.02	0 002
dibromo-3-chloropropane (1,2-) (40 CFR §141.60, §141.61)	0.0002	0.00002
dicamba issue date: 03/87	0 12	0.012
dichlorobenzene o- (40 CFR §141.60, §141 61)	0.6	0.06
dichlorobenzene m- (see o-dichlorobenzene)	0.6	0.06
dichlorobenzene p- (40 CFR §141.60, §141.61)	0.075	0.0075
dichloroethane (1,2-) (40 CFR §141.60, §141.61)	0.005	0.0005
dichloroethylene (1,1-) (40 CFR §141.60, §141.61)	0 007	0.0007
dichloroethylene (cis-1,2-) (40 CFR §141.60, §141 61)	0.07	0.007
dichloroethylene (trans-1,2) (40 CFR §141.60, §141 61)	0.1	0.01
dichloromethane (40 CFR §141.60, §141.61)	0.005	0.0005
dichloropropane (1,2-) (40 CFR §141.60, §141.61)	0.005	0 0005
diclofop-methyl Issue date: 03/87	0.009	0.0009
di(2-ethylhexyl)adipate (40 CFR §141.60, §141.61)	0 4	0.04
di(2-ethylhexyl)phthalate (PAE) (40 CFR §141.60, §141.61)	0.006	0.0006
dimethoate Issue date: 02/86	0.020	0.002
dinoseb (40 CFR §141 60, §141.61)	0.007	0.0007
diquat (40 CFR §141.60, §141.61)	0.02	0.002
diuron issue date: 03/87	0.15	0.015
endothall (40 CFR §141.60, §141.61)	0 1	0.01
endrin (40 CFR §141.60, §141.61)	0 002	0.0002
ethylbenzene (40 CFR §141.60, §141.61)	0.7	0.07

Table D1 – U.S. Environmental Protection Agency and Health Canada NSF/ANSI 61 drinking water criteria

Contaminant (Reference)[1]	Drinking water regulatory level (MCL/MAC) (mg/L)	Single product allowable concentration (SPAC) (mg/L)
Organics/pesticides		
ethylene dibromide (EDB) (40 CFR §141.60, §141.61)	0.00005	0.000005
glyphosate (40 CFR §141.60, §141.61)	0.7	0.07
heptachlor (40 CFR §141.60, §141.61)	0.0004	0.00004
heptachlor epoxide (40 CFR §141.60, §141 61)	0 0002	0.00002
hexachlorobenzene (40 CFR §141 60, §141 61)	0.001	0.0001
hexachlorocyclopentadiene (40 CFR §141.60, §141.61)	0.05	0.005
lindane (40 CFR §141.60, §141.61)	0.0002	0.00002
malathion issue date: 02/86	0.19	0.019
methoxychlor (40 CFR §141.60, §141.61)	0.04	0.004
metolachlor Issue date: 02/86	0.05	0.005
metribuzin issue date: 02/86	0 08	0.008
monochlorobenzene (40 CFR §141 60, §141 61)	0.1	0.01
nitrilotriacetic acid Issue date: 01/90	0.4	0.04
oxamyl (vydate) (40 CFR §141.60, §141.61)	0.2	0.02
paraquat (as dichloride) issue date: 02/86	0.01	0.001
parathion Issue date: 02/86	0.05	0.005
pentachlorophenol (40 CFR §141.60, §141.61)	0.001	0.0001
phorate Issue date. 02/86	0.002	0.0002
picloram (Issue date 06/88)	0.19	0.019
polychlorinated biphenyls (PCB) (40 CFR §141 60, §141.61)	0.0005	0.00005
simazine (40 CFR §141 60, §141.61)	0.004	0.0004
styrene (40 CFR §141.60, §141.61)	0.1	0.01
2,3,7,8-TCDD (Dioxin) (40 CFR §141.60, §141.61)	3E-08	3E-09

Table D1 – U.S. Environmental Protection Agency and Health Canada NSF/ANSI 61 drinking water criteria

Contaminant (Reference)[1]	Drinking water regulatory level (MCL/MAC) (mg/L)	Single product allowable concentration (SPAC) (mg/L)
Organics/pesticides		
terbufos issue date: 01/87	0 001	0.0001
tetrachloroethylene (40 CFR §141.60, §141.61)	0.005	0.0005
2,3,4,6-tetrachlorophenol issue date: 02/87	0.1	0.01
toluene (40 CFR §141.60, §141.61)	1	0.1
toxaphene (40 CFR §141.60, §141.61)	0.003	0.0003
2,4,5-TP (40 CFR §141.60, §141 61)	0 05	0.005
trichlorobenzene (1,2,4-) (40 CFR §141.60, §141.61)	0.07	0.007
trichloroethane (1,1,1-) (40 CFR §141.60, §141.61)	0.2	0.02
trichloroethane (1,1,2-) (40 CFR §141.60, §141.61)	0.005	0.0005
trichloroethylene (40 CFR §141.60, §141.61)	0.005	0.0005
2,4,6-trichlorophenol issue date: 02/87	0.005	0.0005
trifluralin issue date: 02/89	0.045	0.0045
trihalomethanes (total) bromodichloromethane bromoform chlorodibromomethane chloroform (40 CFR §141.64)	0.08 — — — —	0.008 — — — —
vinyl chloride (40 CFR §141.60, §141.61)	0.002	0.0002
xylenes (total) (40 CFR §141.60, §141.61)	10	1
Regulated metals		
antimony (40 CFR §141.60, §141.62)	0.006	0.0006
arsenic Issue date: 10/01	0.010	0.001
barium (40 CFR §141 60, §141 62)	2	0.2
beryllium (40 CFR §141 60, §141.62)	0.004	0 0004
boron issue date: 09/90	5	0.5
cadmium (40 CFR §141.60, §141.62)	0.005	0.0005

Table D1 – U.S. Environmental Protection Agency and Health Canada NSF/ANSI 61 drinking water criteria

Contaminant (Reference)[1]	Drinking water regulatory level (MCL/MAC) (mg/L)	Single product allowable concentration (SPAC) (mg/L)
Regulated metals		
chromium (total) (40 CFR §141.60, §141.62)	0.1	0.01
copper (40 CFR §141.80; 65 FR 1950)	TT[2] (action level 1.3 mg/L)	0.13
lead (at tap) (40 CFR §141 80; 65 FR 1950)	TT[2, 3] (action level 0.015 mg/L)	0.0015
mercury (inorganic) (40 CFR §141.60, §141.62)	0 002	0.0002
selenium (40 CFR §141.60, §141.62)	0 05	0.005
thallium (40 CFR §141.60, §141.62)	0.002	0.0002
Other inorganics		
asbestos (40 CFR §141.60, §141.62)	7[4] MFL	0.7 MFL
bromate (40 CFR §141 64)	0.01	0.005[5]
chloramines (total as Cl_2) (40 CFR §141.65)	4[6]	0.4
chlorine (free as Cl_2) (40 CFR §141.65)	4[6]	0.4
chlorine dioxide (as ClO_2) (40 CFR §141.65)	0.8[6]	0.08
chlorite (40 CFR §141.64)	1	0.1
cyanide (as free cyanide) (40 CFR §141.60, §141.62)	0.2	0.02
fluoride (40 CFR §141.60, §141.62)	1.2[7]	0 12
haloacetic acids (total) (40 CFR §141.64)	0.06	0.006
nitrate (as N) (40 CFR §141.60, §141.62)	10	1
nitrite (as N) (40 CFR §141.60, §141.62)	1	0.1
nitrate + nitrite (both as N) (40 CFR §141.60, §141.62)	10	1
Radionuclides		
beta particle and photon activity (40 CFR §141.16)	4 mrem/y	0.4 mrem/y
gross alpha particle activity (40 CFR §141.15)	15 pCi/L	1.5 pCi/L
combined radium 226 and 228 (40 CFR §141.15)	5 pCi/L	0 5 pCi/L
uranium	0.02 mg/L 13 pCi/L	0.002 mg/L 1.3 pCi/L

Table D1 – U.S. Environmental Protection Agency and Health Canada NSF/ANSI 61 drinking water criteria

Contaminant (Reference)[1]	Drinking water regulatory level (MCL/MAC) (mg/L)	Single product allowable concentration (SPAC) (mg/L)

[1] The references for criteria based on U.S. primary drinking water regulations are from the U.S. Code of Federal Regulations, Title 40 (Protection of Environment), revised as of July 1, 1999. This document is available on-line at http://www.access gpo gov/nara/cfr/cfr-table-search html Issue dates are given for criteria based on Health Canada guidelines. Additional information on the guidelines for these chemicals is available at http://www hc-sc.gc.ca/ehp/ehd/bch/water_quality.html.

[2] TT = treatment technique

[3] For section 9 products, a Q statistic value of 11 µg lead for a 1 L (0 26 gal) draw is used as the evaluation criteria. This is based on the assumption that sources other than the Section 9 device contribute 4 µg for a 1 L (0 26 gal) draw, resulting in a total limit of 15 µg lead for a 1 L (0.26 gal) draw.

[4] MFL = Million Fibers per liter, with fiber length > 10 microns

[5] Beginning January 2005, the Single Product Acceptable Concentration (SPAC) for bromate will be lowered to 0 003 mg/L, unless it is demonstrated to the Joint Committee on Drinking Water Additives by the manufacturers of hypochlorite treatment chemicals that the drinking water industry demand for hypochlorite chemicals cannot be adequately met unless the SPAC remains at 0.005 mg/L.

[6] Value represents the maximum residual disinfectant level (MRDL)

[7] "Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States," August 17, 2001 / Morbidity & Mortality Weekly Report 50 (RR14), 1-42

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Table D2 – NSF International peer-reviewed drinking water criteria

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation
Inorganics				
iodine	7553-56-2	0.3	0 1	NSF action level[1] External peer review date: 04/25/2002
thiocyanate potassium salt sodium salt ammonium salt	 333-20-0 540-72-7 1762-95-4	0.2 (total as SCN)	0 02 (total as SCN)	NSF action level[1] External peer review date: 09/03/2003
titanium and titanium dioxide	7440-32-6 13463-67-7	90 (total as Ti)	9 (total as Ti)	NSF action level[1] External peer review date: 09/04/2003
Organics				
acetophenone	98-86-2	0.2	0.02	NSF action level[1] External peer review date: 09/03/2003
benzyl alcohol	100-51-6	3	0.3	NSF action level[1] External peer review date: 04/26/2002
benzaldehyde	100-52-7	0.9	0.09	NSF action level[1] External peer review date: 04/15/1999
bisphenol A diglycidyl ether bisphenol A diglycideryl ether	1675-54-3 5581-32-8	1 (total)	0.1 (total)	NSF action level[1] External peer review date: 10/03/2002
t-butanol	75-65-0	9	0.9	NSF action level[1] External peer review date: 10/03/2002
di-t-butyl peroxide	110-05-4	0 01	0.01	NSF action level[1] External peer review date: 10/03/2002
n-butyl acetate	123-86-4	1	0.1	NSF action level[1] External peer review date: 04/25/2002
γ-butyrolactone	96-48-0	4	0.4	NSF action level[1] External peer review date: 10/04/2002
2-chloro-1,4-benzenediamine	615-66-7	0.3	0.03	NSF action level[1] External peer review date: 04/20/2004
4-chloro-1,2-benzenediamine	95-83-0	0.2	0.02	NSF action level[1] External peer review date: 04/20/2004
p-chloro-m-cresol	59-50-7	0.7	0.07	NSF action level[1] External peer review date: 04/25/2002

Table D2 – NSF International peer-reviewed drinking water criteria

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation
Organics				
cyclohexanone	108-94-1	30	3	NSF action level[1] External peer review date: 04/26/2002
2,2-dibromo-3-nitrilopropionamide	10222-01-2	0.4	0.09	NSF action level[1] External peer review date: 04/20/2004
2,4-dichlorobenzoic acid	50-84-0	0.1	0.01	NSF action level[1] External peer review date. 04/21/2004
furfural	98-01-1	0.2	0.02	NSF action level[1] External peer review date. 09/03/2003
melamine	108-78-1	3.0	0.3	NSF action level[1] External peer review date. 04/14/1999
methyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate and 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionic acid	6386-38-5 20170-32-5	0 02 (total)	0.002 (total)	NSF action level[1] External peer review date· 04/20/04
methyl isoamyl ketone (MIAK)	110-12-3	0 06	0.006	NSF action level[1] External peer review date· 04/25/2002
oligomeric cyclic ethers CBEL (total OCE 3-6) OCE-3: 1,6,11-trioxacyclo pentadecane OCE-4: 1,6,11,16-tetraoxacyclo-pentadecane OCE-5: 1,6,11,16,21-pentaoxacyclo-pentadecane OCE-6: 1,6,11,16,21,26-hexaoxacyclo-pentadecane	295-63-6 17043-02-6 56890-57-4 64001-05-4	3	0.4	NSF action level[1] External peer review date: 10/04/2002
phenyl glycidyl ether	122-60-1	0.006	0.0006	NSF action level[1] External peer review date: 10/03/2002

Table D2 – NSF International peer-reviewed drinking water criteria

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation
Organics				
di-propylene glycol n-butyl ether	29911-28-2	2	0.2	NSF action level[1] External peer review date. 10/03/2002
propylene glycol n-butyl ether	5131-66-8	2	0.2	NSF action level[1] External peer review date: 10/03/2002
2,4,4'-trichloro-2'-hydroxydiphenyl ether	3380-34-5	0.5	0 05	NSF action level[1] External peer review date· 10/19/2000
1,3,5-trioxane	110-88-3	0.7	0.07	NSF action level[1] External peer review date: 04/20/04

[1] NSF action levels have been derived according to the requirements of NSF/ANSI 61 – 2000 or 2003e, annex A.

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Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Inorganics				
chromium III	16065-83-1	10	1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency consensus date: 04/28/1998
chromium VI	18540-29-9	0.02	0.002	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency consensus date: 04/28/1998
manganese	7439-96-5	0 3	0.03	Derived from the oral RfD on the USEPA IRIS database, with a 3x modifying factor because of the large contribution from food sources and a default 20% relative source contribution for drinking water. Verification date: 05/12/1995
molybdenum	7439-98-7	0 04	0 004	USEPA Draft Health Advisory issue date: 1993
silver	7440-22-4	0.1	0.01	USEPA Lifetime Drinking Water Health Advisory Issue date: 1992
strontium	7440-24-6	4	0.4	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water Verification date: 06/23/1992
Organics				
acetone	67-64-1	6	0.6	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency consensus date: 05/29/03

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
acrolein	107-02-8	0.004	0 0004	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water Agency consensus date: 05/16/2003
acrylamide	79-06-1	0 0001	0.00001	USEPA Drinking Water Health Advisory $10^{-5}/10^{-6}$ cancer risk levels Issue date: 1987
acrylic acid	79-10-7	4	0.4	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. verification date: 02/17/1994
acrylonitrile	107-13-1	0.0006	0.00006	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. verification date: 02/11/1987
aniline	62-53-3	0.06	0.006	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 06/03/87
azobenzene	103-33-3	0.003	0.0003	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 02/03/88
benzidine	92-87-5	0 000002	0 0000002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 12/17/86
benzoic acid	65-85-0	30	3	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 09/17/87
benzotrichloride	98-07-7	0.00003	0.000003	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 08/02/89
benzyl chloride	100-44-7	0.002	0.0002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. verification date. 03/01/1989
bis(chloroethyl)ether	111-44-4	0.0003	0.00003	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 07/23/86

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Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
bis(chloromethyl)ether	542-88-1	0 000002	0.0000002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 05/04/88
bromochloromethane	74-97-5	0.09	0.009	USEPA Lifetime Drinking Water Health Advisory issue date: 1989
bromomethane	74-83-9	0.01	0.001	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date. 05/26/1988
butylbenzyl phthalate	85-68-7	1	0.1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 06/15/1989
n-butanol	71-36-3	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 05/14/1986
caprolactam	105-60-2	4	0 4	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 03/24/88
carbon disulfide	75-15-0	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 08/05/1985
chloral hydrate	302-17-0	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 11/16/1999

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
chlorobenzilate	510-15-6	0.1	0 01	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 05/17/89
cyclohexylamine	108-91-8	1	0.1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 09/17/87
1,4-dibromobenzene	106-37-6	0.07	0.007	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 05/15/1986
1,2-dibromoethane	106-93-4	0.0002	0.00002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Agency Completion Date: 07/26/2004
dichloroacetic acid	79-43-6	0.007	0.0007	USEPA IRIS $10^{-5}/10^{-6}$ upper bound risk levels. Agency Consensus Date. 08/20/2003
p,p'-dichlorodiphenyl dichloroethane (DDD)	72-54-8	0.001	0.0001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 06/24/87
p,p'-dichlorodiphenyl dichloroethylene (DDE)	72-55-9	0.001	0.0001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 06/24/87
p,p'-dichlorodiphenyl trichloroethane (DDT)	50-29-3	0.001	0.0001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 06/24/87
1,3-dichloropropene mixed isomers cis- trans-	542-75-6 10061-01-5 10061-02-6	0.004	0.0004	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Agency Consensus Date: 04/20/2000
3,3'-dichlorobenzidine	91-94-1	0.0008	0.00008	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 11/30/88

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
diethyl phthalate	84-66-2	6	0.6	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 07/16/1987
2,4-dimethylphenol	105-67-9	0.1	0.01	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 02/21/1990
2,6-dimethylphenol	576-26-1	0 004	0 0004	Derived from the oral RfD on the USEPA IRIS database with an default 20% relative source contribution for drinking water. verification date: 01/22/1986
3,4-dimethylphenol	95-65-8	0 007	0 0007	Derived from the oral RfD on the USEPA IRIS database with an default 20% relative source contribution for drinking water verification date: 01/22/1986
dimethylterephthalate	120-61-6	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 10/09/1985
di-n-butyl phthalate	84-74-2	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 01/22/1986
2,4/2,6-dinitrotoluene mixture	N/A	0.0005	0.0005	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 05/03/89
diphenylamine	122-39-4	0.2	0.02	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 07/22/1986

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
1,4-dioxane	123-91-1	0.03	0.003	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels Verification date: 02/03/88
1,2-diphenylhydrazine	122-66-7	0.0005	0.00005	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 10/29/86
1,4-dithiane	505-29-3	0 07	0 007	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water Verification date· 06/24/1992
epichlorohydrin	106-89-8	0.04	0.004	USEPA Drinking Water Health Advisory $10^{-5}/10^{-6}$ cancer risk levels Issue date: 1987
ethylene glycol	107-21-1	10	1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water verification date: 03/19/1987
ethylene glycol monobutyl ether	111-76-2	4	0.4	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water Agency Consensus Date: 11/16/1999
ethylene thiourea	96-45-7	0.0006	0.00006	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 02/20/91
formaldehyde	50-00-0	1	0.1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. verification date: 06/20/1990
1,2,3,4,6,7,8-hepta-chlorodibenzo-p-dioxin	35822-46-9	0.000003	0.0000003	Toxic Equivalency Factor: 0.01
1,2,3,4,6,7,8-hepta-chlorodibenzofuran	67562-39-4	0.000003	0.0000003	Toxic Equivalency Factor: 0.01
1,2,3,4,7,8,9-hepta-chlorodibenzofuran	55673-89-7	0.000003	0.0000003	Toxic Equivalency Factor: 0.01

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Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
hexabromobenzene	87-82-1	0.01	0.001	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. verification date: 11/06/1985
1,2,3,4,7,8-hexachloro-dibenzo-p-dioxin	39227-28-6	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
1,2,3,7,8,9-hexachloro-dibenzo-p-dioxin	19408-74-3	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
1,2,3,6,7,8-hexachloro-dibenzo-p-dioxin	57653-85-7	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
1,2,3,4,7,8-hexachloro-dibenzofuran	70648-26-9	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
1,2,3,7,8,9-hexachloro-dibenzofuran	72918-21-9	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
1,2,3,6,7,8-hexachloro-dibenzofuran	57117-44-9	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
2,3,4,6,7,8-hexachloro-dibenzofuran	60851-34-5	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
hydrazine/hydrazine sulfate	302-01-2	0.0001	0.00001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 06/03/87
isophorone	78-59-1	0.4	0.04	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 08/05/92
isopropylbenzene (cumene)	98-82-8	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 06/06/1997
maleic anhydride	108-31-6	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 03/24/88
4,4'-methylene bis (N,N'-dimethyl)aniline	101-61-1	0.008	0.0008	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 04/05/89

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
methyl ethyl ketone (MEK)	78-93-3	4	0.4	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 09/10/2003
methyl mercury	22967-92-6	0.0007	0.00007	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 06/19/2001
methyl methacrylate	80-62-6	10	1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 11/25/1997
2-methyl naphthalene	91-57-6	0.03	0.003	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 12/11/2003
naphthalene	91-20-3	0.1	0.01	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date: 07/01/1998
nitrobenzene	98-95-3	0.004	0.0004	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 07/08/85

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Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
nitroguanidine	556-88-7	0.7	0.07	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 05/17/1989
N-nitroso-di-n-butylamine	924-16-3	0.00006	0.000006	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 10/29/86
N-nitroso-N-methylethylamine	10595-95-6	0.00002	0.000002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 02/11/87
N-nitroso-di-N-propylamine	621-64-7	0.00005	0 000005	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 02/11/87
N-nitrosodiethanolamine	1116-54-7	0.0001	0.00001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 01/28/87
N-nitrosodiethylamine	55-18-5	0 000002	0.0000002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 10/29/86
N-nitrosodimethylamine	62-75-9	0.000007	0.0000007	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 10/29/86
N-nitrosodiphenylamine	86-30-6	0.07	0.007	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 02/11/87
N-nitrosopyrrolidine	930-55-2	0.0002	0.00002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 10/14/86
1,2,3,4,6,7,8,9-octa-chlorodibenzo-p-dioxin	3268-87-9	0.0003	0.00003	Toxic Equivalency Factor: 0.0001
1,2,3,4,6,7,8,9-octachlorodibenzofuran	39001-02-0	0.0003	0.00003	Toxic Equivalency Factor: 0.0001
1,2,3,7,8-penta-chlorodibenzo-p-dioxin	40321-76-4	0.00000003	0.000000003	Toxic Equivalency Factor: 1
1,2,3,7,8-penta-chlorodibenzofuran	57117-41-6	0.0000006	0 00000006	Toxic Equivalency Factor: 0 05
2,3,4,7,8- penta-chlorodibenzofuran	57117-31-4	0 00000006	0 000000006	Toxic Equivalency Factor: 0.5
pentachloronitrobenzene	82-68-8	0.02	0.002	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 04/15/1987

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
phenol	108-95-2	2	0 2	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus Date. 08/28/2002
m-phenylenediamine	108-45-2	0.04	0.004	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 02/26/1986
phthalic anhydride	85-44-9	10	1	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 02/24/1988
propargite	2312-35-8	0.1	0.01	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 03/23/88
propylene oxide	75-56-9	0.001	0.0001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. verification date: 04/05/1990
quinoline	91-22-5	0.0001	0.00001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Agency Consensus Date: 09/21/2001
sodium diethyldithiocarbamate	148-18-5	0.2	0.02	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 10/09/1985
2,3,7,8-tetra-chlorodibenzo-p-dioxin	1746-01-6	0.00000003	0.000000003	Toxic Equivalency Factor: 1
2,3,7,8-tetrachlorodibenzofuran	51207-31-9	0.0000003	0.00000003	Toxic Equivalency Factor: 0.1
1,1,1,2-tetrachloroethane	630-20-6	0.01	0.001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. verification date: 05/04/1988
1,1,2,2-tetrachloroethane	79-34-5	0.002	0.0002	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 06/26/86

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Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
Organics				
1,2,4-tribromobenzene	615-54-3	0 04	0.004	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 05/15/1986
tributyltin oxide	56-35-9	0.002	0.0002	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Agency Consensus date: 07/02/1997
trichlorofluoromethane	75-69-4	2	0.2	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 05/31/1985
1,2,3-trichloropropane	96-18-4	0.04	0.004	USEPA Lifetime Drinking Water Health Advisory issue date: 1989
1,3,5-trinitrobenzene	99-35-4	0.2	0.02	Derived from the oral RfD on the USEPA IRIS database with a default 20% relative source contribution for drinking water. Verification date: 08/27/1997
2,4,6-trinitrotoluene	118-96-7	0.01	0.001	USEPA IRIS $10^{-5}/10^{-6}$ cancer risk levels. Verification date: 09/22/88

[1] Criteria are derived from the oral RfD on the USEPA IRIS database as follows:

Oral RfD (mg /kg-d) x (70 kg /2 L/d) x relative source contribution factor = TAC (mg/L)

where:

70 kg = assumed adult body weight
2 L/d = assumed adult water consumption
relative source contribution factor = percentage of daily exposure to the substance represented by drinking water (default value is 20%)

Other criteria have been used directly, unless otherwise noted.

[2] The IRIS verification date represents the date the oral RfD or the cancer risk assessment was peer reviewed by the USEPA. Refer to the online IRIS database for the complete update and revision history of the IRIS files: (http://www.epa.gov/ngispgm3/iris/subst).

[3] Toxic Equivalency Factors (TEFs) have been established as a means to compare the potency of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) to individual congeners of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and polychlorinated biphenyls (PCBs). The USEPA uses an approach to dioxin risk assessment methodology in

Table D3 – Drinking water criteria based on USEPA guidance concentrations

Substance	CAS #	Total allowable concentration (TAC) mg/L	Single product allowable concentration (SPAC) mg/L	Source of supporting documentation[1, 2, 3]
which levels of dioxins and furans are analytically determined, the concentration of each congener is multiplied by its respective TEF value, and all the products are totaled to a single 2,3,7,8-TCDD equivalent. Van den Berg et al. 1998. Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and Wildlife Environmental Health Perspectives 106(12):775-792 U.S. Environmental Protection Agency. 2000. Chapter 9. Toxic Equivalency Factors (TEFs) for Dioxin and Related Compounds. From Exposure and Human Health Risk Assessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Part II: Health Assessment for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds. NCEA-I-0386 September 2000. SAB Review Draft http://www.epa.gov/ncea/pdfs/dioxin/part2/fm-chap9.pdf				

– concluded –

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Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Inorganics	
tungsten	007440-33-7
yttrium	007440-65-5
Organics	
acenaphthylene	000208-96-8
acetic acid, propyl ester	000109-60-4
acetophenone, 2,2-dimethoxy-2-phenyl-	024650-42-8
acetophenone, p-isopropyl-	000645-13-6
acetophenone, 2'-methyl-	000577-16-2
acetophenone, 4-methyl	000122-00-9
acetophenone, alpha-hydroxy-	000582-24-1
acetophenone, 3'-methyl-	000585-74-0
acetophenone, 4'-isopropenyl	005359-04-6
acetophenone, 4'-hydroxy-	000099-93-4
acridine	000260-94-6
adipic acid, monomethyl ester	000627-91-8
alcohols, C12-C15, ethoxylated propoxylated	068551-13-3
allyl ether	000557-40-4
allyl phenol ether	001746-13-0
aminopiperidine, 4, 2,2,6,6-tetramethyl-	036768-62-4
aminoundecanoic acid, 12-	000693-57-2
ammonium chloride, octadecyldimethyl{3-(trimethoxysilyl)propyl}	027668-52-6
benzaldehyde azine	000588-68-1
benzaldehyde, 3,5-di-tert-butyl-4-hydroxy-	001620-98-0
benzaldehyde, 4-hydroxy-3-methoxy (Vanillin)	000121-33-5
benzaldehyde, 3,5-dimethoxy-4-hydroxy-	000134-96-3
benzaldehyde, 2-hydroxy-	000090-02-8
benzaldehyde, 2-hydroxy-4-methoxy	000673-22-3
benzaldehyde, hydroxymethoxy-	106799-60-4
benzaldehyde, 2-methyl-	000529-20-4
benzaldehyde, 3-methyl-	000620-23-5
benzaldehyde, 4-methyl-	000104-87-0
benzaldehyde, 2-, 3-, 4-methyl- mixed isomers	001334-78-7
benzaldehyde, tert-butylmethyl-	066949-23-3
benzene, 1-chloro-2-(trifluoromethyl)-	000088-16-4
benzene, 1-chloro-3-(trifluoromethyl)-	000098-15-7
benzene, 1,2,3-trichloro-	000087-61-6
benzene, (1,1-dimethylethoxy)-	006669-13-2
benzene, 1,1'-[(1-propenylthio)methylene]bis-, (Z)-	056195-66-5
benzene, 2-ethoxyethenyl-	017655-74-2
benzene, (2-methoxy-1-methylethyl)-	065738-46-7
benzene, divinyl-	001321-74-0
benzene, (1-methoxy-1-methylethyl)-	000935-67-1
benzene, 1,1-oxybis-	000101-84-8
benzene, 1,3-Dimethyl-5-isopropyl-	004706-90-5
benzene, 4,6-diisopropyl-1,3-dimethyl-	005186-68-5
benzeneacetaldehyde	000122-78-1
benzeneamine, 4-(1-methylethyl)-N-phenyl-	005650-10-2
benzenediamine, ar,ar-diethyl-ar-methyl	068479-98-1
benzenediamine, 5-chloro-1,3-	033786-89-9

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
benzenedimethanol, a,a,a',a'-tetramethyl-1,4-	002948-46-1
benzenedimethanol, a,a,a',a'-tetramethyl-1,3-	001999-85-5
benzenemethanamine, 1,3-	001477-55-0
benzenemethanamine, N-(phenylmethylene)-	000780-25-6
benzenemethanol, 4-(1-methylethyl)-	000536-60-7
benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-	020170-32-5
benzenesulfonamide, 4-methyl-	000070-55-3
benzenesulfonyl isocyanate, 4-methyl	004083-64-1
benzenetricarboxylic acid, 1,2,4-	000528-44-9
benzimidazolone, 3-methyl-2-	001849-01-0
benzimidazolone, 4-methyl-	019190-68-2
benzisothiazolin-3-one	002634-33-5
benzofuran, methyl-	025586-38-3
benzoic acid, 2-cyano-	003839-22-3
benzoic acid, 2,5-dichloro-	000050-79-3
benzoic acid, 3,4-dichloro-	000051-44-5
benzoic acid, mixed isomers (2,4- or 2,5-dichloro-)	035915-19-6
benzoic acid, m-methyl-	000099-04-7
benzoic acid, 4-tert-butyl-	000098-73-7
benzonitrile	000100-47-0
benzoquinone, 2,6-dimethyl-1,4-	000517-61-7
benzoquinone, 2,6-di-t-butyl-	000719-22-2
benzoquinone, 2,5-di-tert-pentyl-p-	004584-63-8
benzothiazole	000095-16-9
benzothiazole, 2-(cyclohexylamino)-	028291-75-0
benzothiazole, ethylamino-	028291-69-2
benzothiazole, 2-(methylmercapto)-	000615-22-5
benzothiazole, 2-methyl-	000120-75-2
benzothiazole, 2-(morpholinothio)-	000102-77-2
benzothiazole-2-thione, N-methyl-	002254-94-6
benzotriazole, 2-(2-hydroxy-5-methyl-phenyl)-	002440-22-4
benzothiazolinone, 2-	000934-34-9
benzoxazole, N-methyl-2-	019776-98-8
benzyl ethyl ether	000539-30-0
benzyl alcohol, 4-ethoxy	006214-44-4
benzyl alcohol, alpha, alpha, 4-trimethyl-	001197-01-9
benzyl alcohol, a,a-dimethyl-p-isopropyl-	003445-42-9
benzylamine	000100-46-9
benzylamine, N,N-dimethyl-	000103-83-3
benzyldiphenylphosphine oxide	002959-74-2
binaphthyl sulfone	032390-26-4
bisphenol A bis(polypropylene glycol) ether	037353-75-6
bisphenol F diglycidyl ether	002095-03-6
borneol	000507-70-0
bromobenzene	000108-86-1
bromophenol	032762-51-9
bromophenol, 2-	000095-56-7
bromophenol, 3-	000591-20-8
bromophenol, 4-	000106-41-2

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Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
1-butanamine,N,N-dibutyl-	000102-82-9
butanedioic acid	000110-15-6
butanediol diglycidyl ether, 1,4-	002425-79-8
butanediol dimethacrylate, 1,4-	002082-81-7
butanenitrile	000109-74-0
butanetricarboxylic acid, 2-phosphono-, 1,2,4-	037971-36-1
butanoic acid	000107-96-2
butanoic acid, 3,3-dimethyl-	001070-83-3
butanone, 1-phenyl-2-	001007-32-5
buten-1-ol, 2-methyl-2-	004675-87-0
buten-1-ol, 3-methyl-2-	000556-82-1
buten-1-ol, 3-methyl-3-	000763-32-6
butenal, methyl-	001115-11-3
butene, 2,3-dichloro-2-methyl-	000507-45-9
butenoic acid, 2-	003724-65-0
butenoic acid, 3-	000625-38-7
butyl isocyanate, n-	000111-36-4
butylamine, N-butylidene	004853-56-9
carbodiimide, di-t-butyl-	000691-24-7
carbonic acid, diisopropyl ester	006482-34-4
chloroethane, 1-butoxy-2-	010503-96-5
chlorotoluene, p-	000106-43-4
cinnamate, 2-ethylhexyl-4-methoxy-	005466-77-3
cyanovaleric acid, 4-	unknown
cyclododecane	000294-62-2
cyclohexadecane	000295-65-8
cyclohexadiene-1-one, 2,6-(1,1-dimethylethyl)-4-methylene-2,5-	002607-52-5
cyclohexadiene-1-one, 2,6-di-tert-butyl-4-hydroxy-4-methyl-2,5-	010396-80-2
cyclohexanamine, 4,4'-methylene-bis-	001761-71-3
cyclohexanamine, N-methyl-	000100-60-7
cyclohexanamine, N-cyclohexyl-	000101-83-7
cyclohexanamine, N,N-dimethyl-	000098-94-2
cyclohexenecarbonitrile	027456-25-3
cyclohexanedimethanamine, 1,3-	002579-20-6
cyclohexane, cis-1-methyl-4-isopropyl-	006069-98-3
cyclohexane, 1-isopropyl-4-methyl-	000099-82-1
cyclohexanemethanol, trans-alpha,alpha,4-trimethyl-	005114-00-1
cyclohexane, methyl-	000108-87-2
cyclohexanol	000108-93-0
cyclohexanol, 3-methyl-	000591-23-1
cyclohexanol, trimethyl-	001321-60-4
cyclohexanol, 4-tert-butyl-	000098-52-2
cyclohexanone, 2-hydroxy	000533-60-8
cyclohexanone, 2-(1-hydroxycyclohexyl)-	028746-99-8
cyclohexen-1-one, 3-methyl-2-	001193-18-6
cyclohexene, 4-cyano also (1-cyano-3-cyclohexene)	000100-45-8
cyclohexyl isocyanate	003173-53-3
cyclohexylurea, dimethyl-	031468-12-9
cyclopentane, trimethyl	030498-64-7

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
cyclopentanol, 2-methyl-	024070-77-7
cyclopentanone	000120-92-3
cyclopentylcyclopentanone, 2-	004884-24-6
decadien-1-al, trans,trans-2,4-	025152-84-5
decadienal, 2,4-	002363-88-4
decamethylcyclopentasiloxane	000541-02-6
decanamide, N,N-dimethyl-	014433-76-2
decanedioic acid, bis(2,2,6,6-tetramethyl-4-piperidinyl)-	052829-07-9
decanedioic acid, dimethyl ester	000106-79-6
decanoic acid, methyl ester	000110-42-9
decylamine, n-	002016-57-1
dehydroabietic acid	001740-19-8
dehydroacetic acid	000520-45-6
di-o-tolylguanidine, 1,3-	000097-39-2
diazacyclotetradecane-2,9-dione, 1,8-	056403-09-9
dibenzylamine	000103-49-1
dibenzyl ether	000103-50-4
dibutyl cyanamide, N,N-	002050-54-6
1,3-dicyclohexylurea	002387-23-7
diethylene glycol monomethacrylate homopolymer	027598-43-2
diethyleneglycol monophenyl ether	000104-68-7
diethylurea, 1,3-	000623-76-7
diglycol chlorohydrin	000628-89-7
dihydro-5-pentyl-2(3H)-furanone	000104-61-0
dihydrobenzofuran, 2,3-	000496-16-2
dihydrofuran, 4-methyl-2,3-	034314-83-5
dihydromethoxymethyl oxopyridinecarbonitrile	000524-40-3
dihydromethyl benzimidazolone	005400-75-9
dimethyl ditallow ammonium chloride	068783-78-8
dimethyl glutarate	001119-40-0
dimethyl succinate	000106-65-0
dimethyl thioacetamide	000631-67-4
dimethyl-3,3'-thiobispropionate	004131-74-2
dimethyl-p-benzoquinone, 2,5-	000137-18-8
dimethylaminopyridine	001122-58-3
dimethylbenzaldehyde, 2,4-	015764-16-6
dimethylbenzaldehyde, 2,5	005779-94-2
dimethylbenzaldehyde, 3,4-	005973-71-7
dimethylcyanamide	001467-79-4
dimethyldiphenyl sulphone	005097-12-1
dimethyldithiocarbamate, methyl	003735-92-0
dimethyldodecanamide, N,N-	003007-53-2
dimethylhexane-2,5-diol, 2,5-	000110-03-2
dioctyldiphenylamine	026603-23-6
dioxacyclododecane-7,12-dione, 1,6-	000777-95-7
dioxadithionane, 1,3,6,7-	005980-67-6
dioxathiocane, 1,3,6-	002094-92-0
dioxolane-1,3, 4-ethyl	029921-38-8
diphenylamine, 4-hydroxy-	000122-37-2

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Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
diphenyl sulfide	000139-66-2
diphenylamine, 4-(diisopropylamino)	064092-29-1
diphenylethanedione, 1,2-	000134-81-6
dipropylamine, 3,3'-diamino-	000056-18-8
dithiolane-2-thione, 1,3-	000822-38-8
docosane	000629-97-0
docosenamide (erucamide)	000112-84-5
dodecamethylcyclohexasiloxane	000540-97-6
dodecanamide	001120-16-7
dodecanamine, 1-	000124-22-1
dodecyl glycidyl ether	002461-18-9
ethan-1-one, 1-(methylphenyl)-	026444-19-9
ethane, 1-(3-hydroxyphenyl)-2-phenyl-	033675-75-1
ethanediamide, N-(2-ethoxyphenyl)-N'-(2-ethylphenyl)-	023949-66-8
ethanol, 2-[2-[2-[2[(1,1,3,3-tetramethylbutyl)phenoxy]ethoxy]ethoxy]-	049796-75-0
ethanol, 2-[2-[2-[(1,1,3,3-tetramethylbutyl)phenoxy]ethoxy]ethoxy]-	058705-51-4
ethanol, 2-[2-[4-(1,1,3,3-tetramethylbutyl)phenoxy]ethoxy]-	002315-61-9
ethanol, 2-(4-methoxyphenoxy) -	005394-57-0
ethanone, 1-(4-hydroxy-3-methoxyphenyl)-	000498-02-2
ethanone, 1-(4-(1-hydroxy-1-methylethyl)phenyl)-	054549-72-3
ethyl hydroxyphthalide	000485-26-7
ethylbenzene acetate	000101-97-3
ethylcyclopentanone	004971-18-0
ethylene glycol dimethacrylate	000097-90-5
ethylene glycol monoethyl ether acetate	000111-15-9
fenchyl alcohol	001632-73-1
fenchyl alcohol, alpha-	000512-13-0
fenchyl alcohol, alpha-	014575-74-7
fluorenone	000486-25-9
formamide, N,N-diethyl-	000617-84-5
formamide, N-methyl-N-phenyl-	000093-61-8
formamide, N-cyclohexyl-	000766-93-8
formamide, N-(1,1-dimethylethyl)-	002425-74-3
formamide, N,N-dimethylthio-	000758-16-7
formamide, N,N-di-n-butyl-	000761-65-9
formamidine, N,N-dimethyl-N'-cyclohexyl-	003459-75-4
formylcyclopentene, 1-	006140-65-4
furan, tetrahydro-2,2,5,5-tetramethyl-	015045-43-9
furfural, 5-methyl	000620-02-0
furylmethylketone, 5-methyl-2-	001193-79-9
geraniol	000106-24-1
gutaraldehyde	000111-30-8
glycidyl ether, 2-methylphenyl-	002210-79-9
guanidine, 1,2,3-triphenyl-	000101-01-9
heneicosane	000629-94-7
heptacosane	000593-49-7
heptadecanoic acid, 16-methyl-, methyl ester	005129-61-3
heptyl aldehyde, n-	000111-71-7
hexacosane	000630-01-3

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
hexanoic acid, 2-ethyl-, methyl ester	000816-19-3
hexanoic acid, methyl ester	000106-70-7
hex-1-ene, 2-ethyl-	001632-16-2
hex-2-en-1-ol, cis-	000928-94-9
hex-2-en-1-ol, trans-	000928-95-0
hex-5-en-1-ol	000821-41-0
hexadecanamide	000629-54-9
hexadecanamide, N,N-dimethyl-	003886-91-7
hexadecene-1	000629-73-2
hexamethylene oxide	000592-90-5
hexamethylene dibenzamide	005326-21-6
hexamethyleneimine, 1-ethyl-	006763-91-3
hexamethylene oxide	000592-90-5
hexanal, 2-ethyl-	000123-05-7
hexanal	000066-25-1
hexanamine, 2-	005329-79-3
hexane, 2,5-dimethyl-	000592-13-2
hexane-2,5-dione	000110-13-4
hexaoxacyclotriacontane, 1,6,11,16,21,26-	064001-05-4
hexen-2-one, 3-, 3,4-dimethyl-	020685-46-5
hexen-2-one, 4-, 3,4-dimethyl-	053252-21-4
hexen-2-one, 3-methyl-4-	072189-24-3
hexen-2-one, 5-methyl-3-	005166-53-0
hexen-2-one, 5-methyl-5-	003240-09-3
hexyne-2,5-diol, 2,5-dimethyl-3-	000142-30-3
hydrocinnamic acid	006386-38-5
hydroxydiphenylamine, 3-	000101-18-8
hydroxypropyl methacrylate, 2-	000923-26-2
icosane	000112-95-8
imidazole, methylphenyl-	000670-91-7
indan-1-ol	006351-10-6
indan-1-one	000083-33-0
indene, 1H-, 2,3-dihydro-1-methyl-	000767-58-8
indene, 1H-, 2,3-dihydro-4-methyl-	000824-22-6
indene, 1H-, 2,3-dihydro-5-methyl-	000874-35-1
indene, 2,3-dihydro- also (2,3-dihydro-1H-)	000496-11-7
indene	000095-13-6
isoalkanes, C9-C12	090622-57-4
isobutylene	000115-11-7
isobutyramide	000563-83-7
isobutyric acid	000079-31-2
isobutyronitrile	000078-82-0
isocrotonic acid	000503-64-0
isoindole, 2H-, 4,7-dione	056460-94-7
isophorone diamine	002855-13-2
Isovanillin	000621-59-0
laurolactam	000947-04-6
maleic anhydride, 2,3-dimethyl-	000766-39-2
mephenesin	000059-47-2

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
methacrylate, lauryl-	000142-90-5
methacrylic acid	000079-41-4
methacrylic acid, 2-hydroxyethyl ester	000868-77-9
methacrylic acid, 3-(trimethylsilyl)propyl ester	002530-85-0
methane, di-t-butoxy	002568-93-6
methane, di-t-butyl-	001070-87-7
methoxybenzene	000100-66-3
methyl anthranilate	000134-20-3
methylcarbamate, methyl N-butyl-N-	054644-60-9
methylcoumarin, 7-diethylamino-4-	000091-44-1
methyl palmitate	000112-39-0
methyl laurate	000111-82-0
methyl salicylate	000119-36-8
methyl stearate	000112-68-1
methyl-4-isopropyl cyclohexane, trans-1-	001678-82-6
methyldiethyl carbamate	004652-44-2
methylene bis(4-methyl-6-tertbutyl-phenol), 2,2'	000119-47-1
2,2'-methylenediphenol	002467-02-9
4,4'-methylenediphenol	000620-92-8
methylenephenethyl alcohol, beta-	006006-81-1
methylindene	029036-25-7
methylpiperidine,1-	000626-67-5
methylthioacetonitrile	035120-10-6
morpholine, methyl-	000109-02-4
morpholine, 4-dodecyl-	001541-81-7
morpholinecarbaldehyde, 4-	004394-85-8
morpholinecarboxamide, N-cyclohexyl-4-	003417-54-7
morpholinepropanenitrile, 4-	004542-47-6
N-butyl formamide	000871-71-6
N-isopropyl-2-methyl-2-propyl-1,3-propanediol dicarbamate	000078-44-4
naphthalene, dimethyl-	028804-88-8
naphthalene, 1,2-dimethyl-	000573-98-8
naphthalene, 1,3-dimethyl-	000575-41-7
naphthalene, 1,4-dimethyl-	000571-58-4
naphthalene, 1,5-dimethyl-	000571-61-9
naphthalene, 1,7-dimethyl-	000575-37-1
naphthalene, 1,8-dimethyl-	000569-41-5
naphthalene, 2,3-dimethyl-	000581-40-8
naphthalene, 2,6-dimethyl-	000581-42-0
naphthalene, 2,7-dimethy-l	000582-16-1
naphthalene, 1-ethyl-	001127-76-0
naphthalene, 2-ethyl-	000939-27-5
naphthalene, ethyl	027138-19-8
nonacosane	000630-03-5
nonanal	000124-19-6
nonanoic acid, 9-oxo-	002553-17-5
nonanoic acid, n-	000112-05-0
norbornene, 5-ethylidene-2-	016219-75-3
octacosane	000630-02-4

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
octadecadienoic acid, (Z,Z)-9,12- , butyl ester	002634-45-9
octadecane, n-	000593-45-3
octadecenoic acid, 6(Z), methyl ester	002777-58-4
octadecenoic acid, 6-, methyl ester	052355-31-4
octadecenoic acid, 7-, methyl ester	057396-98-2
octadecenoic acid, 9(E)-, methyl ester	001937-62-8
octadecenoic acid, 9(Z)-, methyl ester	000112-62-9
octadecenoic acid, 9-, methyl ester	002462-84-2
octadecenoic acid, 10-, methyl ester	013481-95-3
octadecanamide	000124-26-5
octadecenamide	000301-02-0
octadecene, 1-	000112-88-9
octadien-1-ol, 3,7-dimethyl-2,6-	000624-15-7
octadien-2-ol, 2,6-dimethyl-5,7-	005986-38-9
octadien-3-ol, 2,6-dimethyl-1,7-	022460-59-9
octadien-3-ol, 3,7-dimethyl-1,6-	000078-70-6
octadien-3-ol, 3,7-dimethyl-4,6-	018479-54-4
octanal	000124-13-0
octanoate, methyl-	000111-11-5
octaphenyl pentaethylene glycol ether, tert-	038621-31-7
octen-3-ol, 1-	003391-86-4
octylphenoxypentaethoxyethanol, tert-	037809-81-7
oleate, n-butyl-	000142-77-8
oxabicyclo (4.1.0) heptane-3-carboxylic acid, 7-	002386-87-0
oxamide, di-tert-butyl-	037486-48-9
oxaspirodecadienedione, di-(t-butyl)	082304-66-3
oxirane, [(dodecyloxy)methyl]-	002461-18-9
oxybis(propanenitrile)	001656-48-0
palmitate, isopropyl-	000142-91-6
palmitic acid, n-butyl ester	000111-06-8
pentacosane	000629-99-2
pentane, 1-amino	000110-58-7
pentanediol, 2,2,4-trimethyl-1,3-	000144-19-4
pentanenitrile	000110-59-8
pentaoxacyclopentacosane, 1,6,11,16,21-	056890-57-4
pentenal, trans-2-	001576-87-0
penten-2-ol, 3-	001569-50-2
penten-2-one, 3,4-dimethyl-3-	000684-94-6
peroxide, tert-butyl-	000110-05-4
phenanthrene	000085-01-8
phenol, 4-ethoxy-	000622-62-8
phenol, o-(1-phenylethyl)-	004237-44-9
phenol, (phenylethyl)-	051937-33-8
phenol, o-(alpha, alpha-dimethylbenzyl)-	018168-40-6
phenol, p-(alpha, alpha-dimethylbenzyl)-	000599-64-4
phenol, p-phenylethyl-	006335-83-7
phenol, 4-(2-propenyl)-	000501-92-8
phenol, 3,5-dibenzyl-2,4,6-trimenthyl-	unknown
phenol, 2,6-di-t-butyl-4-methoxy-	000489-01-0

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
phenol, 2,2'-methylenebis (6-tert-butyl)-4-ethyl-	000088-24-4
phenol, 4-(1-phenylethyl)-	001988-89-2
phenol, 2-allyl-	001745-81-9
phenothiazine	000092-84-2
phenoxypropanol, 1- (or 2-)	041593-38-8
phenyl isothiocyanate	000103-72-0
phenyl-1-buten-4-ol, 4-	000936-58-3
phenylbutane, 2-	000135-98-8
phenylene) bis-ethanone, 1,1'-(1,4-	001009-61-6
phenylene) bis-ethanone, 1,1'-(1,3-	006781-42-6
phenylenediamine, N,N-bis(1,3-dimethylbutyl)-N'-phenyl-p-	019929-72-7
2,2'-p-phenylenedioxydiethanol	000104-38-1
phenylethanol, 2-	000060-12-8
(phenylimino) cyclohexadiene	002406-04-4
phenylindan, 1,1,3-trimethyl-3-	003910-35-8
phorone	000504-20-1
phosphate, diphenyl-2-ethylhexyl-	001241-94-7
phosphonic acid, (nitrilotris(methylene))tri-, pentasodium	002235-43-0
phthalide [also 1(3H)-isobenzofuranone]	000087-41-2
pinanol	000473-54-1
pinanol (or cis-2-pinanol)	004948-28-1
pinanol, trans-2-	004948-29-2
pinocampheol (also pinocamphone)	000547-60-4
piperazine, 1-(2-aminoethyl)-	000140-31-8
piperidine, 1-formyl	002591-86-8
piperidine, 2-propyl-	000458-88-8
piperidinol, 1,2,2,6,6-pentamethyl-4-	002403-89-6
piperidinol, 2,2,6,6-tetramethyl-4-	002403-88-5
poly(oxy-1,2-ethanediyl), a-isotridecyl-w-hydroxy-, phosphate	073038-25-2
propanal, 2,2-dimethyl-3-hydroxy-	000597-31-9
propanaminium chloride, N,N,N-trimethyl-3-((1-oxo-2-propenyl)amino)-1-	045021-77-0
propane, 1,1-dimethoxy-2-methyl	041632-89-7
propanediol, 2-ethyl-2-butyl-1,3-	000115-84-4
propanenitrile, 3-(diethylamino)-	005351-04-2
propanenitrile, 3,3'-oxybis-	001656-48-0
propanenitrile, 3,3'-thiobis-	000111-97-7
propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester	074381-40-1
propanoic acid, 3-ethoxy-, ethyl ester	000763-69-9
propanoic acid, ethyl ester	000105-37-3
propanoic acid, 2,2-dimethyl-	000075-98-9
propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	000077-68-9
propanoic acid, 2-methyl-, 3-hydroxy-2,4,4-trimethylpentyl ester	074367-34-3
propanoic acid, 2-methyl, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl)propyl ester	074367-33-2
propanol, 1-amino-2 -	000078-96-6
propanol, 1-[4-(1,1-dimethylethyl)phenoxy]-2-	002416-30-0
propanol, 1-phenoxy 2-	000770-35-4
propanol, phenyl-1-	001335-12-2
propanol, 1-propoxy-2-	001569-01-3

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
propanone, 1-phenyl-1-	000093-55-0
propanone, 1-, 2-hydroxy-2-methyl-1-phenyl-	007473-98-5
propenoic acid, 2-methyl-2-, polymer with octadecyl-2-methyl-2-propenoate	027401-06-5
propenone, (dihydroxy methoxyphenyl) phenyl-	018956-15-5
pyrazine, 2-methyl-	000109-08-0
pyrene	000129-00-0
pyridine, 2-methyl-	000109-06-8
pyridine, 2,4-dimethyl-	000108-47-4
pyridine, trimethyl-	029611-84-5
pyridine, 2,4,6-trimethyl-	000108-75-8
pyridine, 1,2,3,4-tetrahydro-1,2,2,6-tetramethyl-	063867-76-5
pyridine, 1,2,3,6-tetrahydro-1,2,3,4-tetramethyl-	090949-18-1
pyridine, 1,2,3,6-tetrahydro-1,2,4,5-tetramethyl-	090949-19-2
pyridine, 1,2,3,6-tetrahydro-1,2,4,6-tetramethyl-, cis-	023513-16-8
pyridine, 1,2,3,6-tetrahydro-1,3,3,6-tetramethyl-	122913-54-6
pyridine, 1,2,3,6-tetrahydro-1,4,5,6-tetramethyl-	090949-20-5
pyridine, 1,2,3,6-tetrahydro-2,2,2,6-tetramethyl-	001124-69-2
pyridine, 1,2,5,6-tetrahydro-2,2,5,5-tetramethyl-	155904-89-5
pyridine, 2,3,4,5-tetrahydro-2,2,4,6-tetramethyl-	200561-41-7
pyrrolidine	000123-75-1
pyrrolidinone, 1-decyl-2-	055257-88-0
quinoline, 3,4-dihydro-2,4,4-trimethyl-	063177-93-5
sodium p-sulfophenyl methallyl ether	001208-67-9
soya alkylamines, ethoxylated	061791-24-0
squalene	007683-64-9
stearic acid, butyl ester	000123-95-5
styrene, alpha-methyl-	000098-83-9
styrene, methyl- (mixed isomers)	025013-15-4
sulfonylbis(4-methyl)-benzene, 1,'	000599-66-6
terephthalic acid, monomethyl ester	001679-64-7
terpineol, alpha-	000098-55-5
tert-butylamine	000075-64-9
tetracosane	000646-31-1
tetradecamethylcycloheptasiloxane	000107-50-6
tetradecanamide	000638-58-4
tetradecanamine, 1-	002016-42-4
tetradecane	001120-36-1
tetraethyleneglycol di-(2-ethylhexoate)	018268-70-7
tetraethyleneglycol dimethacrylate	000109-17-1
tetrahydrofuran, diphenyl-	050637-09-7
tetrahydrofurfuryl alcohol	000097-99-4
tetrahydropyridine, 2,3,4,5-	000505-18-0
tetramethyl urea	000632-22-4
tetramethyldec-5-yne-4,7-diol, 2,4,7,9-	000126-86-3
tetramethyldecynediol	001333-17-1
2,6,10,14-tetramethylhexadecane	000638-36-8
tetramethylpyrazine, 2,3,5,6-	001124-11-4
tetramethylsuccinonitrile	003333-52-6
tetraoxacycloeicosane, 1,6,11,16-	017043-02-6

Table D4 – Threshold of evaluation chemicals[1]

Substance	CAS #
Organics	
tetrathiacyclooctadecane, 1,3,10,12-tetraoxa-6,7,15,16-	099634-55-6
4,4'-thiobis-(6-t-butyl-o-cresol)	000096-66-2
toluenesulfonamide, N-ethyl-4-	000080-39-7
toluenesulfonic acid, p-, butyl ester	000778-28-9
toluidine, N,N-diethyl-p-	000613-48-9
triallyl cyanurate	000101-37-1
tributoxyethyl phosphate	000078-51-3
tributylphosphine oxide	000814-29-9
trichloroaniline, 2,4,5-	000636-30-6
trichloroaniline, 2,3,4-	000634-67-3
trichlorotrifluoroethane	026523-64-8
tricosane, also (n-tricosane)	000638-67-5
triethylamine	000121-44-8
triethyleneglycol dimethacrylate	000109-16-0
triethylsilanol	000597-52-4
trimethylcyclohexanone	050874-76-5
trimethylolpropane trimethacrylate	003290-92-4
trioxane, 1,3,5-trimethyl-	000123-63-7
trioxepane, 1,3,5-	005981-06-6
triphenylphosphate	000115-86-6
triphenylphosphine oxide	000791-28-6
undecanoic acid	000112-37-8
urea, N,N-bis-(1,1-dimethylethyl)-	005336-24-3
urea, 1,1,3,3-tetrabutyl-	004559-86-8
valeronitrile, 2,4-dimethyl-	034372-09-3

[1] For the chemicals listed in this table, the evaluation criteria are 0.003 mg/L under static conditions, and 0.0003 mg/L under flowing conditions.

Annex E[4]
(informative)

Informational drinking water criteria

E.1 General

The drinking water criteria in this annex have not undergone external peer review.

The drinking water criteria in this annex are intended to be used as guidance in the determination of evaluation criteria for those compounds that do not have normative evaluation criteria established. Some of these values, as noted in the tables, are currently under external peer review for inclusion as normative criteria The values in these tables include criteria that have been developed according to the requirements of annex A, but have not been externally peer-reviewed. The tables also include non-regulatory USEPA values that have been reviewed but failed to satisfy annex A toxicity data requirements. Compounds that have been detected only at concentrations below the threshold of evaluation (see annex A, section A 2 7.1) to which the threshold of evaluation protocol has been applied are also listed here.

The drinking water criteria in this annex have not been evaluated for taste and odor considerations at the concentration limits indicated.

In the event that one of the chemicals listed in this annex is detected at concentrations exceeding the guidance evaluation criteria values, a complete toxicity data review should be conducted The review should be performed according to annex A requirements prior to using the informational evaluation criteria values to determine product compliance to this Standard.

The substances listed in tables E1 and E2 are not intended to encompass all of the potential analytes of interest that need to be considered when evaluating products. The user is cautioned that each product may have formulation dependent analytes of interest for which concentration limits have not been determined. In these cases, the user is required to develop acceptable concentration limits based on the requirements of annex A of NSF/ANSI 61 in order to determine full compliance with the Standard

These tables are specific to NSF/ANSI 61. While the tables may be used for evaluation of impurities in drinking water treatment chemicals, the substances listed in these tables may have not been evaluated for use as direct additive drinking water treatment chemicals under NSF/ANSI 60. Use as direct additive drinking water treatment chemicals may require the consideration of different exposure parameters than those used for NSF/ANSI 61 evaluation.

E.2 NSF International drinking water criteria (not externally peer-reviewed)

Table E1 contains drinking water criteria for unregulated contaminants that have been identified as extractants from products covered by this Standard For criteria set by NSF International, the TAC and SPAC criteria have been determined in accordance with annex A of NSF/ANSI 61. External peer review is in progress on these evaluation criteria, as noted in the table. As external peer review is completed, those criteria will be submitted for inclusion as normative evaluation criteria in this Standard.

In the absence of sufficient information to determine a data-derived relative source contribution factor, a default 20% drinking water contribution is assumed Some of the SPAC values do not represent 10% of the corresponding TAC values; either a data deficiency precluded setting of the TAC at a higher value, or a data-derived multiple source factor other than the 10% default value was applied.

[4] The information contained in this annex is informative but has been processed in accordance with ANSI's requirements

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E.3 Informational threshold of evaluation chemicals

Table E2 contains chemicals that have been evaluated using the threshold of evaluation (see annex A, section A.2.7.1), but that may have sufficient toxicity data available that would enable chemical specific risk assessments to be performed if needed. To date, these chemicals have not been detected at concentrations exceeding the threshold of evaluation criteria. In the event that these chemicals are detected at concentrations exceeding the threshold of evaluation criteria, a toxicity data review should be conducted according to annex A prior to using the threshold of evaluation to determine product compliance to this Standard.

Table E1 – NSF International drinking water criteria (not externally peer reviewed)

Substance	CAS #	Total Allowable Concentration (TAC) mg/L	Single Product Allowable Concentration (SPAC) mg/L	Source of supporting documentation[1]
Inorganics				
bismuth	7440-69-9	0.05	0 01 (non-section 9)[2] 0.05 (section 9)[2]	NSF action levels[3] Issue date: 08/02/95
lithium	7439-93-2	1.0	0.3	NSF action levels[3] Issue date: 09/27/99
nickel	7440-02-0	0.1	0.02	NSF action levels[3] Issue date: 07/22/96
vanadium	7440-62-2	0.03	0.003	NSF action levels[3] Issue date: 02/11/00
Organics				
acetaldehyde	75-07-0	0.01	0.01	NSF action levels[3] Issue date: 04/24/96
11-aminoundecanoic acid	2432-99-7	0.05	0.05	NSF action levels[3] In external peer review as of 04/15/99
bisphenol A	80-05-7	0.2	0.02	NSF action levels[3] Issue date: 02/06/97
1,3-butadiene	106-99-0	0.0002	0.00002	NSF action levels[3] Issue date: 1/12/96
butyl acrylate	141-32-2	0.01	0.01	NSF action levels[3] Issue date. 12//13/95
tert - butyl hydroquinone	1948-33-0	0.01	0.01	NSF action levels[3] Issue date: 11/03/95
butyltin compounds (mono- and di- only)	N/A	0.02 (total)	0.004 (total)	NSF action levels[3] Issue date: 12/19/91
dibutylamine	111-92-2	0.01	0.01	NSF action levels[3] Issue date: 08/19/95
dichloropropanol includes: 2,3-dichloro-1-propanol 1,3-dichloro-2-propanol	26545-73-3 616-23-9 96-23-1	0.03 (total)	0.009 (total)	NSF action levels[3] Issue date: 5/97
diethylene triamine	111-40-0	0.01	0.01	NSF action levels[3] Issue date: 11/14/97
diisononyl phthalate	28553-12-0	0.05	0.05	NSF action levels[3] Issue date: 04/06/98
ethanolamine	141-43-5	0 01	0.01	NSF action levels[3] Issue date: 09/17/96
ethyl acrylate	140-88-5	0.01	0.001	NSF action levels[3] Issue date: 01/28/92
ethylenediamine	107-15-3	2	0.2	NSF action levels[3] Issue date: 11/27/99
ethyl-4-ethoxybenzoate	23676-09-7	0.05	0.05	NSF action levels[3] Issue date: 11/17/99
2-ethyl-1-hexanol	104-76-7	0.05	0.05	NSF action levels[3] Issue date: 03/29/95

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Table E1 – NSF International drinking water criteria (not externally peer reviewed)

Substance	CAS #	Total Allowable Concentration (TAC) mg/L	Single Product Allowable Concentration (SPAC) mg/L	Source of supporting documentation[1]
Organics				
hexamethylsiloxane	107-46-0	0.01	0.01	NSF action levels[3] Issue date: 08/15/95
hydroquinone	123-31-9	0.006	0.0006	NSF action levels[3] Issue date: 04/16/92
isophthalic acid	121-91-5	0.01	0.01	NSF action levels[3] Issue date: 12/18/95
maleic acid	110-16-7	0.05	0.05	NSF action levels[3] Issue date: 05/26/95
2-mercaptobenzothiazole	149-30-4	0.04	0 004	NSF action levels[3] Issue date: 11/05/93
methanol	67-56-1	4	2	NSF action levels[3] In external peer review as of 08/06/98
4,4'-methylenedianiline	101-77-9	0.001	0.0001	NSF action levels[3] Issue date: 06/90
1-methylnaphthalene	90-12-0	0.05	0.05	NSF action levels[3] Issue date 09/16/96
N-methyl-2-pyrrolidone	872-50-4	1	0 1	NSF action levels[3] Issue date: 06/17/93
methyltin compounds(mono- and di- only)	N/A	0.03 (total)	0.006 (total)	NSF action levels[3] Issue date: 12/19/91
morpholine	110-91-8	0.01	0.01	NSF action levels[3] Issue date: 10/17/95
2-phenyl-2-propanol	617-94-7	0.05	0.01	NSF action levels[3] In external peer review as of 04/15/99
propylene glycol monomethyl ether	107-98-2	0.05	0.05	NSF action levels[3] Issue date: 2/04/94
terephthalic acid	100-21-0	0.01	0 01	NSF action levels[3] Issue date: 01/10/97
tetrahydrofuran	109-99-9	1	0.37	NSF action levels[3] Issue date: 01/26/96
tetramethylthiourea	2782-91-4	0.002	0.0002	NSF action levels[3] Issue date: undated
toluene diisocyanate 2,4- (80%) and 2,6-(20%) (for specified mixture only)	26471-62-5	0.008	0.0008	NSF action levels[3] Issue date: ~ 6/99
n-triacontane	638-68-6	0.7	0.07	NSF action levels[3] Issue date: 06/10/99
triethanolamine	102-71-6	0 05	0 05	NSF action levels[3] In external peer review as of 04/13/00
triethyl phosphate	78-40-0	0.01	0 01	NSF action levels[3]Issue date: ~ 11/99

Table E1 – NSF International drinking water criteria (not externally peer reviewed)

Substance	CAS #	Total Allowable Concentration (TAC) mg/L	Single Product Allowable Concentration (SPAC) mg/L	Source of supporting documentation[1]
Organics				
trimethylamine	75-50-3	0.01	0.001	NSF action levels[3] Issue date: 11/11/96
vinyl acetate	108-05-4	0 02	0 002	NSF action levels[3] Issue date: 05/03/91

[1] Criteria are derived from the oral RfD on the EPA IRIS database as follows:

Oral RfD (mg/kg/y) x (70 kg/2L/d) x relative source contribution factor = TAC (mg/L)

where:

- 70 kg = assumed adult body weight;
- L/d = assumed adult water consumption; and
- relative source contribution factor = percentage of daily exposure to the substance represented by drinking water (default value is 20%)

[2] For Section 9 products, a 100% multiple source factor was applied during the SPAC calculation, since no other sources of bismuth were expected within the 1 L (0.26 gal) draw specified for section 9 For non-section 9 products, a 20% multiple source factor was applied.

[3] NSF action levels have been derived according to the requirements of ANSI/NSF 61 - 1999a, annex A. External peer review is in progress on some of these substances, as noted

- concluded -

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Table E2 – Threshold of evaluation chemicals having datasets from which specific TAC/SPAC values, or CBEL values, could be set using Annex A[1]

Substance	CAS#
Inorganics	
cobalt	007440-48-4
titanium	007440-32-6
Organics	
acetamide, 2-(diethylamino)-N-(2,6-dimethylphenyl)-	000137-58-6
benzalazine	064896-26-0
benzene, 1-chloro-4-(trifluoromethyl)-	000098-56-6
benzamide	000055-21-0
benzophenone	000119-61-9
benzoguanamine	000091-76-9
benzotriazole, 1,2,3-	000095-14-7
benzyl acetate	000140-11-4
benzyl alcohol, 3,5-di-tert-butyl-4-hydroxy-	000088-26-6
cyanoguanidine	000461-58-5
cyclohexene	000110-83-8
dichlorodifluoromethane	000075-71-8
dichlorophenol, 2,4-	000120-83-2
diethylaminoethanol	000100-37-8
dimethylacetamide, n,n-	000127-19-5
dimethyl adipate	000627-93-0
dimethylaminopropanenitrile	001738-25-6
dimethylformamide, n,n-	000068-12-2
dimethyl phthalate	000131-11-3
diphenyl guanidine, 1,3- (or n,n-)	000102-06-7
diphenyl-p-phenylenediamine, n,n'-	000074-31-7
ethanol, 2-diethylamino-	000100-37-8
ethanol, 2-(dimethylamino)-	000108-01-0
ethanol, 2-phenoxy-	000122-99-6
ethanol, 1-phenyl-	000098-85-1
fluoranthene	000206-44-0
furanmethanol, 2-	000098-00-0
heptanoic acid, n-	000111-14-8
hexamethylenediamine	000124-09-4
hexamethylenetetramine	000100-97-0
hexanoic acid, n-	000142-62-1
hexanoic acid, 2-ethyl	000149-57-5
isobutyl isobutyrate	000097-85-8
(isopropylamino)diphenylamine, 4-	000101-72-4
isopropyltoluene	000099-87-6
methyl acrylate	000096-33-3
methyldiethanolamine, n-	000105-59-9
methylene diphenyl diisocyanate	000101-68-8
methylene bis(n-iso-butylbenzenamine)	088990-59-4
phenylene diamine, n-(1,3-dimethylbutyl)-n'-phenyl-p-	000793-24-8
phenylenediamine, n-phenyl-p-	000101-54-2
phthalic acid, o-	000088-99-3

Table E2 – Threshold of evaluation chemicals having datasets from which specific TAC/SPAC values, or CBEL values, could be set using Annex A[1]

Substance	CAS#
Organics	
piperidine	000110-89-4
sebacate, bis(2-ethylhexyl)-	000122-62-3
silane, gamma-aminopropyl triethoxy-	000919-30-2
tacrine	000321-64-2
tetramethylene sulfone	000126-33-0
tetramethyl piperidinone	000826-36-8
thiabendazole	000148-79-8
triallyl isocyanurate	001025-15-6
triethylene diamine	000280-57-9
tris(2-ethylhexyl) phosphate	000078-42-2
vanillin, o-	000148-53-8

[1] For the chemicals in this table, the evaluation criteria are 0 003 mg/L under static conditions and 0.0003 mg/L under flowing conditions. The chemicals that appear in this table have been detected only at concentrations not exceeding these threshold of evaluation concentrations as established in this standard (see annex A, A.7.1), and have not been evaluated for specific TAC and SPAC values. If any of these chemicals are detected at concentrations exceeding the threshold of evaluation, toxicity data shall be reviewed to determine whether specific TAC and SPAC values can be established, prior to using threshold of evaluation to determine compliance with the Standard.

– concluded –

3

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March 8, 2005

VIA U.S. MAIL & FACSIMILE

Dave Walls
Dept. of Housing & Community Development
Division of Codes and Standards
P.O. Box 1407
Sacramento, CA 95812-1407

Re: Request for Documents Referenced in the Initial Study/Negative Declaration on the Statewide Approval of CPVC

Dear Mr. Friedman:

I am writing to request that the Department of Housing and Community Development ("HCD") provide us with, or make available for our immediate review, all documents referenced in the draft initial study/negative declaration entitled "Addendum to Adopted Mitigated Negative Declaration, State Clearinghouse, No. 2000091089" ("the Negative Declaration") prepared for the proposed amendment of the California Plumbing Code, section 604.1.2, which would expand the approval of chlorinated polyvinyl chloride ("CPVC") to allow its use throughout California ("the Project"). This request is made pursuant to Section 21092, subdivision (b)(1) of the California Environmental Quality Act ("CEQA") and CEQA Guidelines Section 15072, subdivision (f)(4), which require that "all documents referenced in the proposed negative declaration or mitigated negative declaration" be available for review and "readily accessible" during the entire comment period.

Specifically, we seek immediate access to all documents referenced in the Negative Declaration, including any reports or studies used to prepare the Negative Declaration. Responsive documents shall include all correspondence, reports, studies, expert opinions, e-mails, memos, notes of meetings, notes of telephone conversations, all other notes, and any other documents relating to the Project and memorializing HCD's consultation with or obtained as a result of HCD's consultation with the Air Resource Board, the Office of Environmental Health

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Hazard Assessment, the Division of Drinking Water and Environmental Management, the Office of Environmental Health Hazard Assessment, the Department of Health Services, the State Water Resources Control Board, the Regional Water Quality Control Boards, NSF International, American National Standards Institute, Noveon Company, any distributors of CPVC, any distributors of CPVC solvents and cements, any pipe replacement companies, the Construction Industry Research Board, the California Building Industry Association or any other persons or entities with whom HCD has consulted in preparation of the Negative Declaration.

Responsive documents shall include, but not be limited to, the figures provided to HCD by Noveon Company regarding current CPVC usage in California, the Air Resources Board survey regarding pipe cements from consumer products, all documents memorializing discussions with distributors regarding the number of pounds of adhesive products used to install CPVC in residential units, all documents relating to consultations with pipe replacement companies regarding the disposal or recycling of piping materials, the Construction Industry Research Board's 2004 estimate of residential units, the Air Resources Board's 2004 Almanac Data for Reactive Organic Gases Projected Emission Statewide Inventory Estimates, studies consulted in preparation of the Negative Declaration related to the risk of Legionella from drinking water pipe including the studies entitled "*Biofilm Formation and Multiplication of Legionella on Synthetic Pipe Material in Contact with Treated Water under Static and Dynamic Condition*" and "*Legionella Infection Risk from Domestic Hot Water*," studies consulted in preparation of the Negative Declaration relating to the leaching of chemicals from CPVC, and all other documents consulted in preparation of the Negative Declaration.

Responsive documents shall also include all internal memorandum, analyses, studies, reports, meeting notes or other documents or materials generated by HCD in conjunction with its review of CPVC and preparation of the Negative Declaration.

Responsive documents shall also include the petition HCD-P-1/04 from James Kanell to amend the California Plumbing Code, the California Building Standards Commission's findings for petition HCD-P-1/04, HCD's evaluation of petition HCD-P-1/04 and all documents, reports and studies referenced or used in the preparation of the Commission's finding and HCD's evaluation of petition HCD-P-1/04.

Responsive documents shall also include the November 2000 Final Mitigated Negative Declaration (State Clearinghouse No. 2000091089) (the Nov. 2000 MND)

and all documents referenced in the Nov. 2000 MND, including any reports, studies or other documents used to prepare the Nov. 2000 MND.

I will call you to arrange immediate access to these documents. We will send a copy service to expedite our receipt of the documents. Please call me at (916) 444-6201 should you have any questions.

Thank you for your attention to this matter.

Sincerely,

Thomas A. Enslow

TAE:cnh

cc: Richard L. Friedman

4

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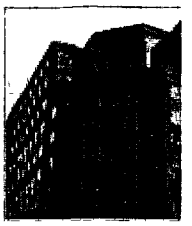

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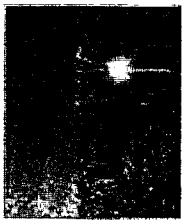

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Last Updated: Feb 28, 2005
Text Only

5

STATE OF CALIFORNIA
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
Division of Codes and Standards

INITIAL STUDY

I. BACKGROUND

1. Department of Housing and Community Development

This project is a response on the part of the Department of Housing and Community Development to the mandate of the Legislature as expressed in the State Housing Law, Sections 17910 - 17995 of the Health and Safety Code, specifically in Sections 17921 and 17922.

Section 17921 directs the Department to adopt, amend, and enforce rules and regulations for the protection of the public health, safety and general welfare of the occupant, and the public governing the erection, construction, and maintenance of all dwellings and structures in the state. The Department's mandate in Section 17921 to adopt rules and regulations for the protection of the public health, safety and general welfare provides the authority for the Department to act in areas not addressed or incompletely addressed by the Uniform Codes. Section 17922 directs that the rules and regulations adopted, amended or repealed from time to time be substantially the same requirements as are contained in the widely used Uniform Codes (such as the Uniform Building Code and the Uniform Plumbing Code). The Legislature has further directed that the Department is to consider local conditions and any amendments to the Uniform Codes.

Pursuant to Section 17958 the Law requires that the governing body of every city or county must adopt ordinances or regulations, within one year, imposing the same requirements as the State's, thus in effect the State regulations are also local regulations when this occurs. Section 17958.5 provides that a city or county may modify or change the requirements published in the State Building Standards Code based on finding of need due to local climatic, geographical, or topographical conditions, subject to certain actions and limitations required of these local entities.

2. Description of Proposed Project

The Department of Housing and Community Development proposes to approve the expanded use of plastic (non-metal) piping systems in the specific applications and conditions listed in the use matrix that follows. The uses are in basic conformance with the proposed 1982 Uniform Plumbing Code (UPC) as published by the International Association of Plumbing and Mechanical Officials (IAPMO). The matrix lists both those plastic pipe applications approved under the 1979 UPC and expanded uses proposed under the 1982 UPC. A copy of the relevent sections of the new code are attached to the end of this Initial Study.

3. Initial Study Authors

This Initial Study was prepared by the Department of Housing and Community Development, Division of Codes and Standards. The Plastic Plumbing Pipe Task Force, representing industry, labor, and interested state agencies participated in the study preparation. Coordination between the Task Force and the Department was provided by Michael C. McMillan, Department EIR Coordinator.

Plastic Pipe Use Matrix

(Yes with an underline - Applications already approved.)
(Yes without an underline - Proposed expanded uses.)

Application	Type of Pipe				
	ABS	PB	PE	PVC	CPVC[2]
Inside a Building					
Not Fire-Rated Construction[1]					
Cold water supply	No	Yes	No	No	Yes
Hot water supply	No	Yes	No	No	Yes
Drain, waste, vent	Yes	No	No	Yes	Yes
Fire-Rated Construction[1] (Exposed locations)					
Cold water supply	No	No	No	No	No
Hot water supply	No	No	No	No	No
Drain, waste, vent	No	No	No	No	No
Fire-Rated Construction[1] (Within fire-resistive construction)					
Cold water supply	No	Yes	No	No	Yes
Hot water supply	No	Yes	No	No	Yes
Drain, waste, vent	Yes	No	No	Yes	Yes
Outside a Building					
Cold water supply	No	Yes	Yes	Yes	Yes
Hot water supply	No	Yes	No	No	Yes
Drain, waste, vent	Yes	No	No	Yes	Yes
Solvents/Glues Used in Installation	Yes	No	No	Yes	Ye

1. Fire-rated refers to material or construction which will withstand a standard fire exposure as determined by recognized testing methods. The amount of time the material resists the spread of fire is indicated by the degree of its fire rating. The higher the fire-rating, the longer the material will resist the spread of fire. Examples of fire-rated materials include concrete, steel, and one-inch thick gypsum board.

   Not fire-rated refers to materials or construction which have no appreciable resistance to the spread of fire. Since these materials or construction methods have little fire resistance, they are not given a fire rating. Examples of not fire-rated materials and construction is that found in a typical wood-frame single family dwelling.

2. CPVC is available for use only under the "other approved materials" local option.

II. ENVIRONMENTAL IMPACTS

(Explanations of all "yes" and "maybe" answers are provided in Section III).

	Yes	Maybe	No
I. **Earth.** Will the proposal result in:			
a. Unstable earth conditions or in changes in geologic substructures?		X	
b. Disruptions, displacements, compaction or overcovering of the soil?			X
c. Change in topography or ground surface relief features?			X
d. The destruction, covering or modification of any unique geologic or physical features?			X
e. Any increase in wind or water erosion of soils, either on or off the site?			X
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?			X

	Yes	Maybe	No
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?			X
2. Air. Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?		X	
b. The creation of objectionable odors?			X
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?			X
3. Water. Will the proposal result in:			
a. Changes in currents, or the course of direction of water movements, in either marine or fresh waters?			X
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?			X
c. Alterations to the course or flow of flood waters?			X
d. Change in the amount of surface water in any water body?			X
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?		X	
f. Alteration of the direction or rate of flow of ground waters?			X
g. Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?			X
h. Substantial reduction in the amount of water otherwise available for public water supplies?			X
i. Exposure of people or property to water related hazards such as flooding or tidal waves?			X

	Yes	Maybe	No
4. **Plant Life.** Will the proposal result in:			
a. Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?			X
b. Reduction of the numbers of any unique, rare or endangered species of plants?			X
c. Introduction of new species of plants into an area, or in a barrier to the normal replenishment of existing species?			X
d. Reduction in acreage of any agricultural crop?			X
5. **Animal Life.** Will the proposal result in:			
a. Change in the diversity of species, or numbers of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects)?			X
b. Reduction of the numbers of any unique, rare or endangered species of animals?			X
c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?			X
d. Deterioration to existing fish or wildlife habitat?		X	
6. **Noise.** Will the proposal result in:			
a. Increases in existing noise levels?		X	
b. Exposure of people to severe noise levels?			X
7. **Light and Glare.** Will the proposal produce new light or glare?			X
8. **Land Use.** Will the proposal result in a substantial alteration of the present or planned land use of an area?			X
9. **Natural Resources.** Will the proposal result in:			
a. Increase in the rate of use of any natural resources?		X	

	Yes	Maybe	No
b. Substantial depletion of any nonrenewable natural resource?			X
10. Risk of Upset. Will the proposal involve:			
a. A risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?		X	
b. Possible interference with an emergency response plan or an emergency evacuation plan?		X	
11. Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?		X	
12. Housing. Will the proposal affect existing housing, or create a demand for additional housing?		X	
13. Transportation/Circulation. Will the proposal result in:			
a. Generation of substantial additional vehicular movement?			X
b. Effects on existing parking facilities, or demand for new parking?			X
c. Substantial impact upon existing transportation systems?			X
d. Alterations to present patterns of circulation or movement of people and/or goods?			X
e. Alterations to waterborne, rail or air traffic?			X
f. Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?			X
14. Public Services. Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:			
a. Fire protection?		X	
b. Police protection?			X
c. Schools?			X

	Yes	Maybe	No
d. Parks or other recreational facilities?			X
e. Maintenance of public facilities, including roads?			X
f. Other governmental services?			X
15. Energy. Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?			X
b. Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?		X	
16. Utilities. Will the proposal result in a need for new systems, or substantial alterations to the following utilities:			
a. Power or natural gas?			X
b. Communications systems?			X
c. Water?			X
d. Sewer or septic tanks?			X
e. Storm water drainage?			X
f. Solid waste and disposal?			X
17. Human Health. Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?		X	
b. Exposure of people to potential health hazards?		X	
18. Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?			X
19. Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?			X
20. Cultural Resources.			
a. Will the proposal result in the alteration of or the destruction of a prehistoric or historic archaeological site?			X

	Yes	Maybe	No
b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?			X
c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?			X
d. Will the proposal restrict existing religious or sacred uses within the potential impact area?			X
21. Mandatory Findings of Significance.			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		X	
b. Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals? (A short-term impact on the environment is one which occurs in a relatively brief, definitive period of time while long-term impacts will endure well into the future.)		X	
c. Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.)		X	
d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?		X	

III. DISCUSSION OF ENVIRONMENTAL EVALUATION

1.a. Earth. Approval of the expanded use of plastic plumbing pipe may result in unstable earth conditions. If plastic pipe carrying liquid under pressure, when installed under slab foundations, fails (leaks) more frequently than metal pipe, the soil beneath the foundations may become saturated. This saturation may lead to unstable earth conditions in situations such as hillside homes, structures on expansive soils, or structures near areas of previous landslides or soil creep.

2.a. Air. Should the expanded use of plastic plumbing pipe be approved in California, a significant demand may be produced for additional pipe. This demand may lead to increased production or a general increase in activity at major chemical plants. Increased production may produce an increase in air emissions with a potential decrease in ambient air quality.

Major chemical and petrochemical plants in California are operated under permits issued by Air Quality Management Districts. An increase in production or refinery operations within the limits of existing air quality permits is not considered a significant impact. To increase production above limits set in existing permits would require a new permit or permit modification by the Air District. At that time, the impact and potential mitigation measures for air quality would be assessed by the Air District. Expanded use of plastic plumbing pipe is not expected to result in substantial new air emissions or a deterioration of ambient air quality.

3.e. Water. Should the expanded use of plastic plumbing pipe be approved in California, toxic substances may be released in small quantities from the pipe and pipe solvents into the liquid within the pipe in quantities more or less than from metal pipes and solders. There is considerable controversy in the scientific and technical community over what substances may leach from plastic plumbing materials and in what quantities. A similar controversy exists for metal pipes. The potential impact, if any, of plastic pipe leachates from an expanded use of plastic pipe on surface water quality is not known. Expanded use of plastic plumbing pipe may result in an alteration of surface water quality.

5.d. Animal Life. Approval of the expanded use of plastic plumbing pipe may lead to a deterioration of existing aquatic habitat. As discussed under item 3.e., the potential impact of plastic pipe leachates on surface water in relation to the existing impact from metal pipe leachate is not known. If the impact was adverse, it may in turn affect aquatic organisms and their habitat. The magnitude of the potential impact on aquatic habitats should be assessed.

6.a. Noise. Submitted into the record of the plastic pipe project is a letter from Hilliard and Bricken, Consulting Acoustic and Energy Engineers, Santa Ana, California, stating, "There is strong evidence that there is a real advantage of using cast iron (rather than plastic riser drain pipe) to decrease the rushing noise of water." In homes where plastic pipe is in use, however, no significant impact has been reported from increased noise levels of water flowing through the pipes. Expanded use of plastic plumbing pipe is not expected to produce a significant adverse increase in existing noise levels.

9.a. Natural Resources. Approval of the expanded use of plastic plumbing pipe may result in a change in the rate of use of petroleum, a natural resource. Approval may result in a decrease in the rate of use of copper (in copper pipe) and iron and zinc (in galvanized pipe). The magnitude of the petroleum increase, and whether it would be a significant impact, is not known.

10.a. and b. Risk of Upset. In the event of a fire in a building containing plastic plumbing pipe, toxic fumes may be released from the burning pipe. Different types of plastic would produce different fumes on combustion. If toxic fumes or smoke were produced, they may interfere with emergency evacuation. Additional information may be needed before it can be determined if plastic pipe would contribute to unusual fire spread or that the toxicity generated by the combustion of plastic pipe would not extend beyond the area of initial exposure in quantities sufficient to prove hazardous from through-penetrations in fire-rated construction or within fire-rated construction.

11. Population. Approval of the expanded use of plastic plumbing pipe may alter the location, distribution, density, or growth rate of an area. Should the potential reduced cost of plastic pipe have a significant effect on the cost of housing, the cost reduction may alter population distributions. The availability of new lower cost housing may attract populations from other areas.

12. Housing. Approval of the expanded use of plastic plumbing pipe in California may affect existing housing and create a demand for additional housing. If plastic plumbing pipe is found to be both less expensive to purchase and to install, the cost of constructing new homes may be reduced.

14.a. Public Services. As discussed previously in Items 10.a. and b., the use of plastic plumbing pipe in multi-story buildings may produce toxic fumes or smoke in quantities that may prove hazardous. Should plastic plumbing pipe be shown to create a hazardous situation during a fire, approval of the expanded use of plastic plumbing pipe may result in a need for altered governmental services, namely fire protection.

15.b. Energy. Expanded use of plastic plumbing pipe may or may not require a net increase in energy consumption over the manufacture, shipping, and installation of conventional pipe materials. The relative energy use between pipe materials needs to be assessed.

17.a. and b. Human Health. The most significant source of potential adverse impact which may occur if plastic pipe is approved for expanded plumbing use is in the area of human health. There may be a potential health hazard from chemicals leached into drinking water from the pipe and solvents used in joining the pipe. Each type of pipe may have different types of leachate. The quantities of such leachates, including singularly, in combination, and/or in aggregate, their relevant acute or chronic adverse effects on human health, and the relative contribution exposure to plastic pipe pollutants would have on an occupant of housing using plastic pipe needs to be assessed, as is feasible. The similar impact should be assessed relative to the effect from approved metal pipes (such as lead pipe and lead-soldered copper pipe and associated fluxes).

The manufacturing and installation of some types of plastic pipe may expose plant workers or pipe-trades craftsmen to potential dermal and inhalation health hazards from solvent vapors, solvent skin contact, and airborne particulates. The health and safety impact may be greater or less than that associated with metal pipe installation. The potential for significant adverse impacts of both metal and plastic pipe on worker safety should be assessed and compared.

21.a. Quality of the Environment. Approval of the expanded use of plastic plumbing pipe may degrade the quality of the environment. As described under Items 3.e. and 5.d., the expanded use of plastic pipe may cause a change in surface water quality and may cause a deterioration of existing aquatic habitat.

21.b. Short-Term vs. Long-Term Goals. Approval of the expanded use of plastic plumbing pipe may achieve short-term goals (e.g., lower cost, reduced energy use, easier installation) to the disadvantage of long-term goals (e.g., potential for continuous exposure to chemicals in water supply).

21.c. Cumulative Impact. The cumulative impact of expanded use cannot be assessed until the magnitude of the individual impacts is determined.

21.d. Effects on Humans. Expanded approval of plastic plumbing pipe may produce an adverse effect directly or indirectly on human beings.

Additional Potential Impacts.

Fiscal. Approval of the expanded use of plastic plumbing pipe may reduce the cost of plumbing materials for construction. The magnitude of cost difference between metal and non-metal materials as a percentage of total construction cost should be assessed. Potential differences in labor costs for installation of the two materials should be assessed.

IV. DETERMINATION

On the basis of this initial evaluation, I find approval of the expanded use of plastic plumbing pipe MAY have a significant effect on the environment. An ENVIRONMENTAL IMPACT REPORT is required to assess the magnitude of any potential adverse effects, discuss alternatives to the project as proposed, and determine feasible mitigation measures to reduce identified impacts.

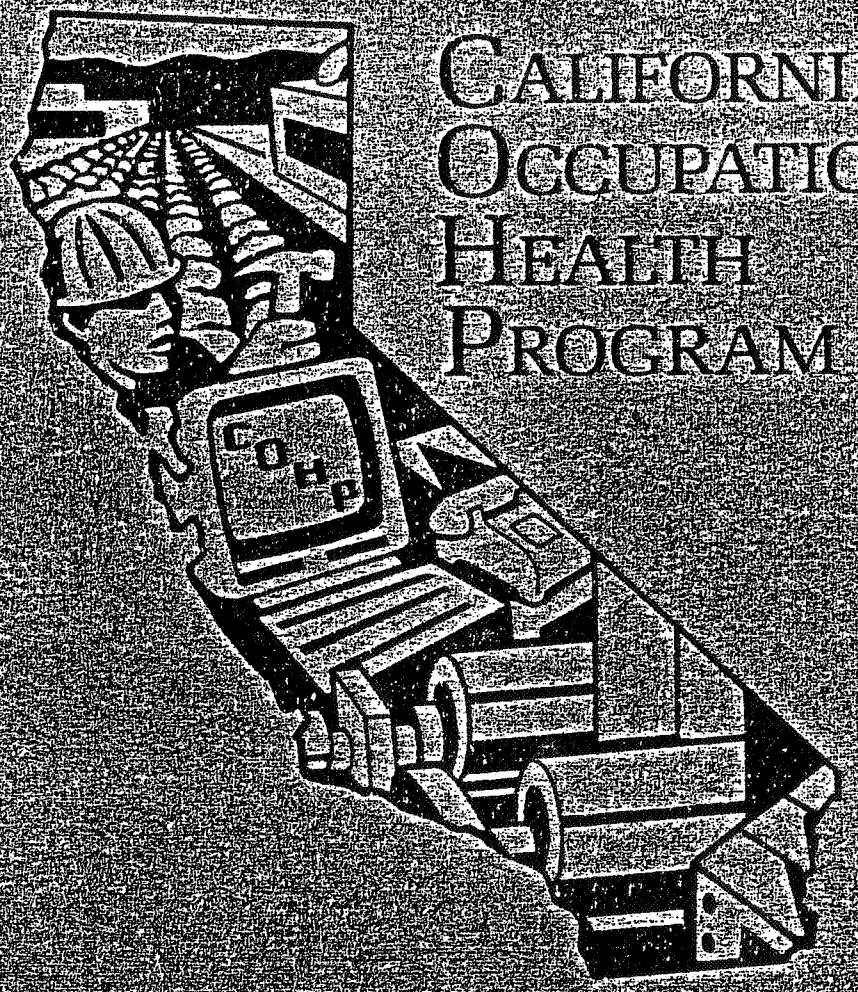
Date: _____

By: I. Donald Terner, Director
Department of Housing and Community Development

6

Plastic Pipe Installation:

Potential Health Hazards for Workers



CALIFORNIA OCCUPATIONAL HEALTH PROGRAM

dhs

Plastic Pipe Installation:
Potential Health Hazards for Workers

Field Investigation FI-88-002

California Occupational Health Program
2151 Berkeley Way, Room 504
Berkeley, California 94704

April, 1989

California Department of Health Services
Kenneth W. Kizer, M.D., M.P.H., Director

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Copies of this report are available to the public. Inquiries should be directed to:

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CONTENTS

Acknowledgements ii
Contents iii
Summary v
Introduction 1
Methods 3
General 3
Site Selection 3
Cemented plastic pipe exposures 5
Polybutylene pipe exposures 8
Copper pipe exposures 8
Quality assurance 8
Evaluation criteria 9
Data analysis 9
Results 13
Study Group 13
Laboratory quality assurance 17
Dimethyl formamide 18
THF, MEK, CHX, and ACE 18
CPVC, PVC, and ABS dust 24
Polybutylene and flux decomposition products 25
Metal fumes 25
Safety hazards 26
Discussion 27
Comparison with previous studies 27
Study limitations 27
Applications of data 29
Health significance 31
Conclusions 33
Recommendations 35
References 37
Tables 41
Figures 51
Appendix A. Air sampling methods 59
Appendix B. Site identification methods 61
Appendix C. Exposure limits and toxicity summaries 67
Appendix D. Characteristics of sites monitored 79
Appendix E. Contents of bulk primer and cement samples 81
Appendix F. Composition of copper solders 83
Appendix G. Results of laboratory quality assurance program 85

SUMMARY

During August-November 1988, the California Occupational Health Program studied possible worker health hazards associated with the installation of plastic pipe. The state's Department of Housing and Community Development, anticipating a possible change in the State Plumbing Code that would allow increased use of plastic pipe, requested the study to assess whether the change would result in more-hazardous working conditions for plumbers installing the new materials, particularly chlorinated polyvinylchloride (CPVC) pipe. The cements used to join the pipes contain several organic solvents, including tetrahydrofuran (THF), methyl ethyl ketone (MEK), cyclohexanone (CHX), acetone (ACE), and dimethylformamide (DMF). Workers installing copper pipe and polybutylene (PB) pipe were also monitored for exposures to toxic substances. The study was limited to residential construction.

Exposure monitoring was conducted at 35 construction sites throughout California and in the state of Georgia. At each plastic pipe installation site, short-term and full-shift solvent exposures were assessed by collecting a variety of personal air samples. Urine samples were obtained from most workers monitored, and analyzed to determine whether significant concentrations of the solvents had been absorbed. Workers soldering copper pipes were monitored for exposures to metal fumes and flux decomposition products.

In 60 air samples representing full-shift exposures, the average concentrations were 47 ppm THF and 10 ppm MEK. The highest measured full-shift exposures were 158 ppm for THF (79% of the airborne exposure limit) and 45 ppm for MEK (23% of the exposure limit). Based on an index of combined exposure to THF, MEK, CHX, and ACE, one worker's exposure to these substances exceeded the exposure limit. Workers installing CPVC potable water pipe had average exposures 1.8 to 8.5 times higher than the average exposures of workers installing other types of plastic pipe, based on the combined exposure index. Workers who experienced the highest exposures were installing numerous fittings in highly enclosed areas—crawl spaces and an attic. Exposures to DMF were low: measurable DMF was detected in only three of 28 air samples at a maximum concentration of 0.4 ppm, and no evidence of DMF exposure was found in 26 urine samples.

Concentrations of THF and MEK in workers' urine samples were closely correlated with their airborne exposures. Workers who had extensive skin contact with plastic-pipe primers and cements had higher urine concentrations of THF—relative to their airborne exposures—than workers with light skin contact, suggesting that a significant portion of a worker's total THF dose may be absorbed through the skin. Four of 29 workers who had heavy skin contact with THF-containing products had urine THF concentrations up to seven times higher than the maximum among workers with little skin contact, even

though their airborne exposures were comparable. The total THF exposures (airborne plus dermal) of these workers were estimated to be equivalent to airborne exposures of 150-740 ppm (75-370% of the exposure limit). These estimated values incorporate considerable uncertainty, but they represent the best available interpretation of the urine concentrations.

Short-term exposures under some conditions were substantially higher than the full-shift exposures, up to 529 ppm for THF (210% of the short-term exposure limit) and 95 ppm for MEK (32% of the limit). Short-term exposures were highest at CPVC installation sites, especially during extended work in highly-enclosed spaces. The probability that the limit for combined short-term exposure to THF, MEK, CHX, and ACE would be exceeded, during installation of CPVC potable water pipe, was estimated to be 3.5% for any randomly-selected 15-minute period. This value indicates a 68% chance that the combined exposure limit would be exceeded during at least one 15-minute period over a typical 8-hour work day. Work-area ventilation rates were the strongest and most consistent determinant of exposure levels.

The potential health impacts of these full-shift and short-term exposures (especially THF) are not fully known. The occupational exposure limit for THF has been set to prevent eye, nose, and throat irritation, so workers exposed above the limit may experience irritation. Concurrent exposures to MEK, CHX, and ACE may exacerbate any sensory irritation. The effects of chronic exposure to THF have not been studied in humans or animals. THF absorbed through the skin is unlikely to contribute to sensory irritation but could amplify any systemic effects from ongoing exposure to THF and other solvents.

Exposures associated with installation of copper and polybutylene pipe were studied in less detail, but were found to be well below the established workplace exposure limits for all substances monitored. Workers in every type of pipe installation faced significant safety hazards, especially when working with chain saws in awkward positions and when working atop unsafe ladders. Most employees (90%) had received no health and safety training.

To reduce work-related health hazards, the following recommendations should be implemented consistently during all plastic-pipe installation. Employers should arrange installations such that no plastic-pipe cementing in completely enclosed areas is necessary and should provide forced ventilation when work in enclosed areas is unavoidable. Employers should establish work practices that prevent extensive skin contact with primers and cements, and primers should be supplied strongly tinted to discourage skin contact. Employers should provide comprehensive, effective health and safety training for all workers.

INTRODUCTION

Newly-built housing units currently have as many as six separate piping systems installed. The two systems common to every unit are potable water supply (pw) and drain, waste, and vent (DWV). Other plumbing systems may also be required by the developer or buyer, or by local ordinance; these systems are for: fire sprinklers, garden sprinklers, natural gas, and "condensate lines" for draining air conditioners and clothes-washer overflow.

In February, 1988, the California Occupational Health Program (COHP), a unit of the state Department of Health Services, was asked by the Department of Housing and Community Development to assess the health hazards associated with installation of three types of water-supply pipe: chlorinated polyvinylchloride (CPVC), polybutylene (PB), and copper. At the time of the study, only copper and galvanized steel pipe were approved by the State Plumbing Code for distribution of potable water within structures. Local city or county building departments could approve other plumbing materials, but few chose to do so. The Department of Housing and Community Development was considering an amendment to the State Plumbing Code which would grant statewide approval for use of CPVC and PB potable-water pipe, and sought to determine whether this regulatory change would ultimately impact the health of workers installing the pipe.

In keeping with the original request, the goal of this study was to evaluate the work-related health hazards that occur during installation of the three types of water-supply pipe: CPVC (designated CPVC-pw), PB, and copper. However, three other types of pipe were also included in the study: CPVC pipe used for fire sprinkler systems (CPVC-fire), DWV pipe made of polyvinylchloride (DWV-PVC), and DWV pipe made of acrylonitrile-butadiene-styrene copolymer (DWV-ABS). These pipes were included for two reasons. First, CPVC-fire was included because the fact that CPVC-pw was not approved statewide severely limited the number of CPVC-pw sites available for monitoring. CPVC-fire installation served as a surrogate in determining the patterns of exposure and the factors affecting exposure levels. Installation of CPVC-pw and CPVC-fire systems are similar in many respects, including: the size of the joints cemented, the primers and cements used, and the work practices and general worksite conditions. Second, DWV-PVC and DWV-ABS pipes were included because plumbers who install water-supply pipe are often assigned to install DWV lines during subsequent hours or days, so consideration must be given to cumulative exposures.

CPVC pipe joints are cemented together with fittings in a two-stage process. Parts to be cemented are prepared with a primer, then coated with cement, and finally the parts are held together for a few seconds while the bond is made. Both the primers and the cements have organic solvents as their major

constituents. Five solvents are used in varying proportions: tetrahydrofuran (THF), methyl ethyl ketone (MEK), and cyclohexanone (CHX) are in most cements and primers; acetone (ACE) and dimethylformamide (DMF) are in a few. CPVC resin is added to the cements. DWV-PVC and DWV-ABS joints are made in a similar manner, but primer is usually not used. DWV joints are usually much larger (1 1/2 to 4 inches diameter) than the joints in CPVC-pw or CPVC-fire lines (1/2 to 1 1/2 inches). PB joints are not cemented; they are either made with mechanically-crimped fittings or by a thermal fusion process. Copper joints are soldered together using propane (or other gas) torches. Most copper-pipe solders are mainly tin, with small amounts (less than 10% in all) of copper, silver, or antimony added. Lead is prohibited for use in potable water systems.[1] A flux, usually organic acids in a greasy base, is applied before soldering to ensure good flow properties.

Exposures associated with installation of plastic pipe have been assessed in three previous studies.[2,3,4] In each of those studies, full-shift exposures to THF, MEK, CHX, ACE, and DMF were below the respective exposure limits. However, short-term exposures have been found to approach or exceed the short-term exposure limits for THF and MEK, especially during work in enclosed areas. The frequency of overexposures and the effects of various job factors on exposure levels have not been previously determined. In other industries, dermal absorption of DMF has been shown to add significantly to workers' total exposure;[5] plumbers sometimes have extensive skin contact with DMF-containing primers or cements, but dermal absorption of DMF during plastic pipe installation has not been adequately evaluated. The physical and chemical properties of THF, MEK, and CHX (especially their solubility in both water and non-polar solvents) suggest that they, too, might be well absorbed through the skin from primers and cements, but dermal absorption of these substances has not been studied.

In this study, a combination of air monitoring and biological (urine) monitoring were used to evaluate average exposures that occur during various types of pipe installation, to identify the highest exposures that are likely to occur and the conditions that produced them, and to assess the importance of dermal absorption. Measured exposure levels were used to assess the likelihood that workers installing CPVC, PB, and copper pipes would suffer adverse health effects. However, no assessment of health status was included in this study.

METHODS

General

Field monitoring was preceded by walk-through inspections of nine plastic and copper pipe installation sites. A detailed monitoring protocol was developed, and was followed closely throughout the study. Methods used for collection and analysis of air samples are summarized in Appendix A.

Monitoring of workers' exposures was conducted by one- to four-person study teams, each led by a qualified industrial hygienist. At each pipe installation site monitored, supervisors were interviewed to obtain basic information about the work being done at the site, particularly the activities of each worker. Individual workers were interviewed to obtain basic demographic information and to determine their job training, specific health and safety training, usual use of protective equipment, and any observations about unusual conditions on the day of monitoring. At the end of each work day, workers were asked to report any symptoms of ill health that they had experienced during the day.

With few exceptions, the exposures of all workers performing the installation of interest at each site were monitored. All workers were asked to participate in exposure monitoring if they met a single criterion: that they were assigned to work on the installation of interest for at least one-half of the workday monitored. At some sites, workers were split into several crews to install different types of plumbing in separate structures. If the study team was large enough, it was then split to follow the individual crews, otherwise a single installation was selected for monitoring. Detailed records were maintained of each workers' activities, including the number of joints completed, use of protective equipment, and uncommon work practices. At the end of each day, workers were asked to report whether they had experienced any of the following symptoms during the day: headaches, dizziness, skin rash, dried skin, gastrointestinal disturbances, or irritation of eyes, nose, or throat.

Site Selection

The primary goal of the site selection process was to identify representative CPVC-pw installation sites. An extensive but fruitless search was made in California and surrounding states. Ultimately CPVC-pw and DWV-PVC sites were identified and monitored in Georgia. Installations of other types of plastic pipe (CPVC-fire and DWV-ABS) were identified in California and a sample selected for monitoring. Installations of copper potable water and PB pipe were also identified. In all more than 1500 calls were completed in the effort to identify and select appropriate sites, and to arrange site visits.

The first task in site selection was to determine whether any California cities or counties permitted the use of CPVC for potable water distribution within residential units. The most up-to-date information available listed 44 cities and counties which had approved some or all of the expanded uses of plastic pipe as of 1985. Appropriate building or plumbing department officials were contacted in each of these jurisdictions—and 44 other California cities and counties—and were questioned about the use of CPVC-pw. Only four areas (South Lake Tahoe, Palm Springs, Marin County, and Nevada County) permitted CPVC-pw in their local plumbing code. Most plumbing inspectors from these areas reported that they "discouraged" the use of CPVC and that the contractors themselves chose not to use it. The site search process is described in detail in Appendix B.

When no CPVC-pw installation sites could be located in California, the U.S. manufacturer of CPVC resin suggested that Atlanta, Georgia was the area most likely area to provide an adequate number of CPVC-pw sites for monitoring. Under that recommendation, the CPVC-pw site selection process was then focussed on the Atlanta area. The regional CPVC sales representative contacted two of the largest plumbing contractors in the area and provided several other contractors' names. Other leads were provided by the Atlanta building department, referrals from individual contractors, referrals from local plumbing suppliers, and the telephone directory. The local plumbers union was contacted but could not provide additional leads. In all, approximately 30 Atlanta-area contractors were contacted. Most of these did not use CPVC or were not using it at the time monitoring was scheduled. Every contractor known to be using CPVC-pw in the Atlanta area during the monitoring period agreed to participate in the study. PVC was the main pipe material used for DWV at the Georgia sites monitored; all DWV-PVC monitoring was done in that state.

The search for CPVC-pw sites led to a realization that CPVC pipe was widely used in fire sprinkler systems in California. To identify potential monitoring sites, communities requiring fire sprinklers were identified, and individual sites were located by a process similar to that used for CPVC-pw sites. As monitoring of CPVC-pw and CPVC-fire sites progressed, sites were sought that had specific characteristics not yet included in the study: multiple-unit buildings, installations in enclosed spaces, use of DMF-containing glues, and high ambient air temperatures.

ABS is the pipe most widely used for DWV in California residences. Monitoring of DWV-ABS installation was conducted almost entirely in Northern California at sites of plumbing contractors whose names were provided by pipe trades unions.

All copper-installation monitoring was done in Northern California, primarily at sites suggested by the pipe trades unions. Using the same search methods designed for CPVC, no fusion-method PB potable water site was located in California. The only PB installation site monitored was a snow-melt

system in Northern California, which was located with the assistance of a manufacturer's sales representative.

Cemented plastic pipe exposures

Dimethyl formamide

At each site of CPVC-pw, CPVC-fire, DWV-PVC, or DWV-ABS installation, the presence of DMF in all primers and cements to be used was established at the beginning of the work day by measuring DMF vapors in the headspace of the can with a colorimetric indicator tube (Draeger DMF 10/b). Products with bulk DMF concentrations of above 0.5% were expected to have headspace DMF concentrations detectable by this method. For workers using DMF-containing products, full-shift air samples were collected using silica-gel sorbent tubes. End-of-shift urine samples were also collected, and were analyzed for the DMF metabolite monomethyl formamide (MMF) by standard methods.[6] For each worker, extent of skin contact with primers and cements was classified by an industrial hygienist according to specified criteria into one of three categories: Light (skin contact less than 25 cm^2, 10 times or less); Heavy (contact repeated more than 10 times, or contact of more than 25 cm^2 at least once); and Gloves (cotton, leather, or rubber gloves worn during most cementing). Skin contact was rated separately for morning and afternoon work periods.

THF, MEK, CHX, and ACE

Full-shift exposures to airborne THF, MEK, and CHX were evaluated by collection of personal air samples with charcoal passive dosimeters (3-M #3500). For workers handling primers or cements labelled as ACE-containing, this substance was also determined in the passive dosimeter samples. End-of-shift urine samples were collected, and urine MEK was analyzed by an established method;[7] urine THF and CHX were analyzed similarly. The collection period for the passive dosimeters was the last four hours of the workshift. This period was selected to yield data comparable with previous studies of MEK exposure (in other industries), which have shown good correlation between end-of-shift urine concentrations and airborne MEK exposures measured by 4-hour charcoal passive monitors.[8,9,10] Based on previous walk-through inspections and worker interviews, no major difference were expected between morning and afternoon exposures, so exposure levels measured by the 4-hour passive monitors were provisionally assumed to be equivalent to full-shift exposures. Possible differences between morning and afternoon work patterns are discussed later. Skin contact was classified as described above. Work area temperature was measured during the mid-afternoon.

Short-term exposures were evaluated by collection of 15-min samples according to a stratified sampling scheme. The sampling scheme was developed to maximize the number of samples collected during each workers' highest exposure periods while maintaining a degree of randomness about the specific exposure periods to be monitored. The sampling strata were based on two easily-observable parameters of work activity: work in enclosed vs. unenclosed areas, and the number of joints cemented per 15-min period. Five distinct strata were defined:

I	no cementing
IIa	unenclosed area with 1-7 joints per 15 min
IIb	unenclosed area with 8 or more joints per 15 min
IIIa	enclosed area with 1-7 joints per 15 min
IIIb	enclosed area with 8 or more joints per 15 min

Each stratum had a specified sampling frequency for each worker-day (I, one sample per two site-days; IIa, one per worker-day; IIb, 50% of all periods; IIIa, 50% of all periods; IIIb, 100% of all periods). Individual sampling periods were selected systematically within each stratum. (For example: the first 15-min IIb period was sampled; the next 15-min IIb period was not sampled; the next was; the next was not; etc.) As members of the study team became familiar with the pipe installation process, they could generally anticipate the number of joints that would be cemented in an upcoming 15-min period, and plan their monitoring accordingly. For data analysis, samples were categorized according to the actual conditions during the monitoring period, even if these were different than anticipated. Each 15-min period throughout the workday was classified into one of the five sampling strata to form a complete record of the time each worker spent in the strata.

For each air sampling period, 15-min personal air samples were collected using sorbent tubes. In most cases, two samples were collected simultaneously—one on activated charcoal and one on ambersorb XE-347—because no single sorbent is normally recommended for THF, MEK, CHX, and ACE. Each charcoal tube was analyzed for THF, MEK, and CHX, and for ACE if products labelled as ACE-containing were used. Analysis of an initial batch of 22 samples showed good agreement between the paired charcoal and ambersorb tubes (weighted average deviation was less than 15% for each substance), so most ambersorb tubes were not analyzed. After all charcoal tubes had been analyzed, ambersorb tubes collected during 14 high-exposure periods were analyzed to confirm the charcoal-tube results. For 15-min exposures measured by both paired tubes, the higher result was used for subsequent data analysis.

For each 15-min monitoring period, the air-flow rate in the worker's breathing zone was measured with a hot-wire anemometer, the work space was classified as enclosed or unenclosed, and breathing-

zone temperature was measured. Working conditions were recorded for each period, including: the number of joints cemented, spills, and the potential for secondary exposure (defined as other workers cementing within 10 feet or in the same enclosed area). A "joint cemented" was defined as cementing pipe in both ends of a two-opening fitting, or in two openings of separate fittings.

Real-time exposure profiles

An H-Nu 101 photoionization detector (PID) was used to qualitatively characterize exposure variability. Real-time measurements were made of workers' exposures during CPVC installations of potable water and fire sprinkler systems by placing the probe of the PID in the workers' breathing zones. Exposure levels were recorded continuously on a strip chart; average concentrations for each 12-sec interval were later estimated from the strip chart to summarize the data. Because CHX and DMF concentrations were low, and because the PID is almost equally sensitive to MEK and THF, the total organic vapor concentration indicated by the PID was considered to represent the sum of the MEK and THF concentrations. The PID's response was expected to be unaffected by variations in the relative proportions of these two solvents in the primers and cements used.

Although the PID provided interesting information about the variability of exposure levels within 15-min periods, it had some major limitations. The instrument was cumbersome, and keeping the probe in the workers' breathing zones sometimes became downright dangerous as they went up and down ladders and into tight spaces. MEK or THF calibration gases were unavailable (n-hexane and isobutylene were used instead, with appropriate sensitivity correction factors), making exact calibration impossible. For that reason, the PID data were used to provide qualitative, rather than quantitative, information about the variability of contaminant levels within 15-min periods. For periods in which exposures were assessed concurrently with the PID with 15-min sorbent-tube samples, the sorbent tube result was taken as the "true" 15-min exposure. The PID data was then adjusted by applying a correction factor, such that the average of all 12-sec concentrations in the monitoring period was equal to the 15-min average concentration of the concurrent sorbent tube sample.

CPVC/PVC dust

For the few workers who used high-speed power saws to cut plastic pipe, exposure to plastic dust was evaluated by collecting personal air samples on 37-mm membrane filters (0.8 μm pore size PVC or PTFE). The filters were analyzed gravimetrically. In one case, two samples were collected simultaneously: one of total particulates and one of the respirable fraction only, using a cyclone pre-selector. Workers who cut pipe with hand tools or with low-speed reciprocating saws were judged to have no significant exposure to plastic pipe dust.

Polybutylene pipe exposures

Samples of thermal decomposition products during one PB fusion operation were obtained. Sample collection included the day's entire exposure, and a background air sample was collected at the same time. The non-volatile and semi-volatile fraction of the sample was collected on a 37-mm filter (0.8 µm pore size, at 2 l/min). The volatile fraction was collected on a sorbent tube (400 mg pre-washed and desorbed Tenax in stainless steel) at 50 ml/min. The Tenax tube was preceded by a Teflon filter to prevent the non-volatile and semi-volatile fraction of the sample from reaching the sorbent. Formaldehyde, an expected thermal degradation product, was collected simultaneously on 2-(hydroxymethyl)piperidine sorbent tubes (Orbo-24) at 100 ml/min, and analyzed by gas chromatography.

The filters were desorbed in an ultrasonically-agitated solvent bath and analyzed by gas chromatography-mass spectrometry (GC-MS). The Tenax was thermally desorbed and analyzed by GC-MS. The GC-MS analysis consisted of: a) quantitation of 82 EPA priority pollutants (polyaromatic hydrocarbons, chlorinated hydrocarbons, phthalates, pesticides, PCBs, and chloro- and nitro-phenols) and b) a semi-quantitative identification of all other GC peaks.

Copper pipe exposures

Workers installing copper pipe were monitored for full-shift exposures to metal fumes and flux decomposition products. Breathing zone samples (13) were collected on 37 mm filters and analyzed by standard methods (plasma emission or atomic absorption spectroscopy). Concentrations of copper, tin, silver, antimony, and lead were determined. Bulk samples of several brands of solder were obtained and analyzed by plasma emission spectroscopy.

Samples of thermal decomposition products generated during copper pipe soldering operations were obtained for two workers at separate sites. Tenax, teflon filter, and Orbo-24 tube samples were collected and analyzed as described above. An additional Orbo-24 tube sample was collected for a second worker at one of the sites.

Quality assurance

Each air sample representing a full-shift exposure included all exposure periods for the work day, unless otherwise noted. Sorbent tubes, dosimeters, and urine samples were cooled on ice immediately after collection, and then kept frozen until analyzed. Flow rates for air-sampling pumps were checked regularly in the field with calibrated rotameters, and in the laboratory with bubble flowmeters. Any

flow-rate changes between calibrations were assumed to have been linear during periods of pump operation. Field blanks were submitted for analysis along with air sampling media; the number of blanks was approximately 10% of the number of samples.

A laboratory quality assurance (QA) protocol was established for the THF, MEK, and CHX samples collected on charcoal and ambersorb, and for DMF samples collected on silica gel. The analytical laboratory spiked sorbent tubes with known quantities of the analytes (as a mixture for THF, MEK, and CHX). The tubes were shipped on ice to the study team, completely relabelled, and then returned to the laboratory mixed together with field samples such that the two could not be distinguished. The spiking levels were equivalent to the quantity obtained by sampling exposures of 20%, 50%, 100%, and 200% of the exposure limits. At each spiking level, three tubes were prepared. All charcoal and silica gel tubes were analyzed, along with one ambersorb tube at each spiking level.

Urine samples of two unexposed individuals were sent for analysis along with the field samples. In addition, four samples of urine from unexposed individuals were spiked with MMF (0.009 mg/ml) and sent for analysis along with field samples. Five field samples and two spiked samples were each analyzed for THF, MEK, and CHX on two or three separate days.

Evaluation criteria

The exposure limits used for evaluating exposures to the substances monitored are shown in Appendix C. These exposure limits were taken from U.S. OSHA standards, from NIOSH Recommended Exposure Limits, or from ACGIH TLVs and STELs.[11,12,13] Concentrations of MMF and MEK in urine were evaluated according to the Biological Exposure Indices (BEIs) established by ACGIH (40 $\mu g_{MMF}/g_{creat}$ and 2000 $\mu g_{MEK}/l$, respectively). Appendix C contains brief summaries of the toxicity of each substance, together with comments on the quality of information used to set the exposure limits.

For antimony, animal evidence—supported by limited epidemiologic data—suggests that it is carcinogenic, but it has not been evaluated by the International Agency for Research on Cancer. The exposure limit shown in Appendix C (0.5 $\mu g/m^3$) may not protect against carcinogenicity. Similarly, recent epidemiologic evidence has suggested that DMF may cause testicular cancers, but the carcinogenicity of DMF has not been fully evaluated. The DMF exposure limit listed in Appendix C (10 ppm) may not protect against carcinogenicity.

Data analysis

The purposes of the statistical analysis were to describe the exposure measurements and to explore the relationships between job factors and exposure levels. The methods used for data analysis closely followed a plan specified prior to data collection. For each substance and for each pipe installation type, arithmetic mean exposures and the associated geometric standard deviations (GSDs) were calculated. For all calculations, substances present in air samples at concentrations below the analytical limits of quantitation were assigned a value of 2/3 the quantitation limit, a value chosen to represent expected exposures at the low end of log-normally-distributed data. (This choice of assignment for concentrations not quantified had little bearing on the analysis of THF and MEK exposures, since most exposures were far above the detection limits). A confidence level of 95% was used for all statistical tests, unless otherwise noted. Most analysis was performed with a standard microcomputer software package.[14]

THF, MEK, CHX, and ACE all exert similar effects at low to moderate exposure levels, and workers were typically exposed to a mixture of the four. Therefore, a combined exposure index was calculated for each full-shift solvent sample, as:

$$\%FSEL = \Sigma(c_i/FSEL_i) \times 100\%$$

where %FSEL is the combined exposure index (sometimes referred to as dose), c_i is the airborne concentration of each substance, and $FSEL_i$ is the full-shift exposure limit for each substance, as shown in Appendix C. An analogous value was also calculated for short-term exposures, as

$$\%STEL = \Sigma(c_i/STEL_i) \times 100\%$$

where %STEL is the combined short-term exposure index and $STEL_i$ is the short-term exposure limit for each substance.

Estimates of average full-shift exposures to THF, MEK, CHX, ACE, and %FSEL were calculated two ways. First, the air samples collected by 4-hour passive dosimeters were assumed to adequately represent the entire work day. To check this assumption, the fraction of total on-site work time included in the afternoon dosimeter-sampling periods was compared to the fraction of the days' total joints that were cemented during those periods. Second, the average 15-min exposure levels in each sampling stratum, weighted by the fraction of total time worked in that stratum, were used to reconstruct average full-shift exposures. The estimates derived by these two methods were then compared.

As an additional comparison, the short-term exposure data were also used to estimate each individual's exposure during the 4-hour monitoring periods. For this calculation, measured exposure levels for each worker-day in each sampling stratum were weighted by the percentage of time (during 4-hour passive monitoring) worker in each sampling stratum. When no worker-specific exposure data were available for a stratum, the average for that stratum and installation was substituted. The estimates derived for each worker were then compared with the exposure levels measured by passive dosimeters.

Exposures in each particular category were expected to have an approximately log-normal distribution. After data collection, histograms of the log-transformed exposure levels were visually inspected and were observed to approximate a log-normal model for each type of exposure (goodness-of-fit not tested). Therefore, log-transformed exposure data were used when performing statistical tests that require normally-distributed data for validity. For each type of exposure (except as noted), the fraction of the entire exposure distribution which would be expected to exceed the relevant exposure limit was estimated using standard techniques,[15] based on the estimated geometric mean and GSD of the exposure distribution.

A standard analysis-of-variance procedure was used to determine whether average (log-transformed) exposure levels differed significantly among installation types and sampling strata. Several short-term exposure measurements were made for most workers, so analysis-of-variance techniques were used to assess the portion of overall exposure variability attributable to between-workers vs. within-worker variability, for each installation type and sampling stratum with multiple measurements.

Multiple regression modeling techniques were used to explore the relationships between various job factors and the resulting exposures. Exposures were hypothesized to be related to four factors—number of joints cemented, composition of bulk products, air flow rate, and temperature—according to the following model:

$$c_i = \frac{k_N N^{b_N} \times k_B B_i^{b_B} \times k_T T^{b_T}}{k_V V^{b_V}}$$

where c_i is the airborne concentration of substance *i*, N is the number of joints cemented, B_i is the concentration of substance *i* in the bulk products used (as a weight-weight fraction), T is the temperature, and V is the air flow rate. The exponents b_V and b_B were expected *a priori* to equal -1 and unity, respectively, while no particular values were expected for the exponents b_N or b_T, or for the

coefficients k_N, k_B, k_T, or k_V. A logarithmic transformation was used to place this model in a form suitable for standard multiple linear regression analysis:

$$\ln(c_i) = b_N \ln(N) + b_B \ln(B_i) + b_T \ln(T) + b_V \ln(V) + \ln(k_N\, k_{Bi}\, k_T\, k_V).$$

Unfortunately, the coefficients k_N-k_V combine as a single constant term in this log-linear model.

The individual variables were entered stepwise into an overall model, in order of decreasing partial correlation. Variables that were significantly associated with exposure in the overall model were then interpreted to be determinants of exposure.

Several adjustments to the raw data were made to facilitate the regression analysis, as described below. To form a simple index for the concentration of each substance in all bulk products used at a given site, the primer and cement concentrations were averaged together. Where more than one primer or cement were used, their concentrations were also averaged. For full-shift exposures, day-long mean air flow rates were calculated by averaging all worker-specific air flow rates measured during the day. For the log-transformed model, values equal to zero (for example, zero joints cemented) could not be transformed, so they were replaced by values equal to one-half the lowest non-zero number recorded (in this example, 0.5 joints).

The effects of secondary exposure were assessed by analysis of variance, with sampling strata and presence or absence of secondary exposures as the grouping factors. The effects of spills on exposure levels were assessed similarly.

The relationships between airborne exposures and the resulting urine concentrations were evaluated with linear regression analysis (THF and MEK only). Possible differences in this relationship between Heavy and Light skin-contact groups were tested with standard analysis-of-covariance techniques (log-transformed data). For MEK, the regression results were compared with previously published values.

RESULTS

Study Group

Sites

Exposure monitoring was conducted at 35 pipe installation sites (CPVC-pw, 6; CPVC-fire, 9; DWV-PVC, 5; DWV-ABS, 5; PB, 1; and copper, 9). Where two types of pipe installation were monitored at a single construction site, these were counted as separate installation sites if they took place in different buildings and if individuals worked on only a single type of installation. At four sites, workers installed both CPVC-pw and DWV-PVC concurrently; these were classified as CPVC-pw sites, and all exposures measured at those sites were included among the CPVC-pw exposures. Follow-up monitoring was conducted at seven sites (1 day, 6 sites; 2 days , 1 site). In all, 43 site-days of exposure monitoring were completed (CPVC-pw, 8; CPVC-fire, 13; DWV-PVC, 7; DWV-ABS, 5; PB, 1; and copper, 9). Characteristics of the sites are described in Appendix D, including the type of installation, number of workers monitored, and the source from which the site was identified. At three sites, workers installed subassemblies that had been prefabricated off-site. Monitoring was conducted at each of the three prefabrication shops (sites 7, 9, and 35).

Several sites were selected for monitoring specifically because they featured working conditions that had not yet been monitored at an adequate number of sites. For example, sites with multiple-unit dwellings were sought, and five such sites were monitored. The special selection criteria are shown in Table 1. Conversely, some possible sites were rejected because their working conditions had already been monitored at several other sites, and the exposure levels were believed to be similar among sites.

Plumbing contractors generally were cooperative, often to the extent of scheduling their jobs to match the times that monitoring could be conducted. Three contractors refused several efforts to recruit them into the study; whether their workers installed CPVC pipe was not determined. General contractors were usually indifferent to the presence of the study team; only one general superintendent expressed hostility. All workers monitored were asked whether working conditions were normal on the day of the study. None reported that their employers had arranged their work to minimize exposures, or had encouraged workers to alter their work practices. In fact, a few contractors attempted to maximize the amount of plastic-pipe cementing to be done during the monitoring periods; others seemed content to let small details slow their workers' progress.

Workers

The exposures of 78 workers (1-4 per site) were monitored. For 15 workers, exposures were monitored again on subsequent work days, for a total of 95 worker-days of monitoring (CPVC-pw, 18; CPVC-fire, 34; DWV-PVC, 18; DWV-ABS, 9; PB, 1; and copper, 15). The workers ranged in age from 20 to 66 years (mean 32 years); all were men. Workers' experience in the pipe trades ranged from three months to 41 years. In this study group, the workers installing DWV-ABS pipe had the most experience (mean 18 years); workers installing CPVC-fire had the least (mean 1.7 years). Only 8 (10%) reported receiving specific health and safety training, which usually focused on worksite safety: ladders, hard hats, electrical wires. Only two workers (3%) said they had been informed about potential hazards of the substances in plastic pipe primers and cements, and most workers had read the warning labels on the products they used. Many workers considered the label warnings—such as "avoid contact with skin" and "use only in well-ventilated areas"—to be comically impractical.

A typical work day for these workers consisted of eight hours of work time, with a half-hour lunch and two 15-min breaks. Workers often reported first to the pipe contractor's shop for assignment and to pick up supplies, so actual time at the installation site was usually less than 8 hours. Work days were then broken up into various tasks, such as setting up, drilling and other preparation, running pipe, making joints, "blocking" the pipe to prevent movement, and cleaning up. Workers installing plastic pipe spent an average of 49% of each day's on-site time in stratum I (no cementing). The remaining time was distributed among the other sampling strata as follows: IIa, 30%; IIb, 7%; IIIa, 12%; and IIIb, 2%. The distribution of work time varied among the installation types: workers installing DWV-ABS spent the most time on non-gluing tasks, workers installing CPVC-fire spent the least. The amount of work time spent in various sampling strata also differed among workers within each installation type. For example, during CPVC-pw installation, the range of times spent in each stratum are as follows (expressed as 10%-90% percentiles): I, 19-59%; IIa, 12-70%; IIb, 0-28%; IIIa, 0-46%, IIIb, 0-1%. The average amount of work time in each installation type and sampling stratum is shown in Table 2.

Most workers were completely cooperative with the study and interested in its purpose. Five workers declined to give urine samples. At one site, three of five workers refused all monitoring. At two sites, plumbing contractors had arranged for installation to be done by subcontractors rather than hourly employees; these workers participated in the study but tended to be more rushed and less cooperative than regular wage-earners.

Work practices

Individual work practices were mainly the result of decisions made by workers and their employers, but were sometimes influenced by site characteristics. For example, workers did extensive cementing in crawl spaces at two sites (17 and 23) because their employer had not assigned them to the sites until after the house was framed, leaving no way that the under-floor plumbing could be installed without working in the crawl space. Remodeling, such as retrofitting of fire sprinklers in existing structures, inevitably requires some work in enclosed spaces. Most workers installing plastic pipe preferred well-ventilated areas whenever possible. Some people tended to work by themselves; others worked together in one area, depending on the wishes of both the contractors and the workers themselves.

At some sites, each worker drilled holes for the pipe that he would install. At others, one worker was assigned to drill holes all day while other workers laid pipe and cemented joints. The latter arrangement would tend to concentrate primer and cement exposures on a few workers.

Four workers (5%) wore cotton work gloves for most of their work, and two (3%) wore rubber gloves when handling glues and primers. Three workers (4%) wore protective eyewear during some part of the day, four (5%) wore kneepads, and two wore hard hats. None wore organic vapor respirators, but two wore dust masks when working in dusty areas.

Primer or cement spills were observed during 14 (5%) of the 15-min periods monitored; most were small (area<0.25 m^2). Some workers applied primers and cements liberally, such that their clothes, the pipes, and nearby surfaces were sprinkled with drips and small splashes. Four workers (5%) used primers, "primer/cleaners" or other solvents to remove cement from their hands at the end of the day, and one did so repeatedly throughout the day.

Usually, the amount of cement applied to the pipe and fittings was more than would fit in the joints; the excess ran down the pipe when the joint was assembled. Some workers wiped this excess from each joint, using a rag or—more commonly—their fingers. A common reason for application of excessive cement was that the daubers provided to apply cement to the joints were often too big, so that all the cement would be squeezed out each time the dauber was pushed into a fitting. Smaller daubers are provided with smaller primer and cement cans, but these small cans are typically more expensive. One worker trimmed new daubers to match the size of the joints to be glued, and one other worker transferred his favorite (small) dauber into each new can he used.

The experience and skill level of workers in this study varied tremendously. In general, workers with little experience were unsure of their tasks and proceeded slowly. They tended to cement few joints

in any given period, and thus had fewer and briefer opportunities for exposure than workers who could move rapidly from joint to joint. Workers' caution in handling primers and cements was not determined by their skill level. For example, some experienced workers were quite adept at avoiding skin contact with primers and cements, while others had given up all hopes of keeping clean in favor of working quickly. Similar variation was observed among inexperienced workers. Because few workers had received health and safety training, and because few workers received specific guidance from their employers about such work practices as care in avoiding spills, use of protective equipment, and methods used to remove cement from hands, these factors were left largely to personal taste.

Installation of CPVC-pw pipe has important features, different from the other installation types, that could have a significant effect on exposures. Installation is relatively simple and fast, so workers cemented more joints per day doing CPVC than any other installation type (mean of 73 joints per day for CPVC-pw vs. 29-33 joints per day for the other installation types). CPVC-pw installation is usually done later in the overall construction process than is DWV installation, so the buildings tend to be more enclosed (but still not fully enclosed by walls, windows, and doors). In addition, CPVC-pw and DWV-PVC were being installed concurrently at three sites, creating the possibility that contaminants released by both installations could combine to yield higher exposures than each one singly. CPVC-fire and DWV-ABS were not installed concurrently with any other plastic pipe at any sites monitored.

Symptoms reported

Of the workers whose exposures were monitored, 28 (39%) reported experiencing one or more illness symptoms during the day. The most common of these were irritation of eyes, nose, and throat (10% of all worker-days), dizziness (9%), and dried skin (9%). The percentage of workers reporting other symptoms are listed in Table 3. These data were not designed for analysis of differences in self-reported symptoms among various exposure groups or of the factors related to symptom reporting, so no quantitative analysis is presented here. However, the most commonly reported symptoms are noteworthy in that they are consistent with the known (or suspected) acute effects of overexposure to THF, MEK, CHX, and ACE: irritation of mucous membranes and skin, and depression of central nervous system function.

Pipe installation materials

Contents of the bulk primer and cement samples are listed in Appendix E. Good agreement was found between the substances identified in the products and ingredients listed on their labels. In many products, the main solvent was THF, followed by MEK (average for all products: THF, 45%; MEK, 19%). DMF was present at concentrations above 1% in two products used at five sites (20% of all plastic-pipe cementing sites); these were a DWV-PVC cement and a CPVC-fire cement. The simple

headspace test used to determine presence of DMF was accurate for all products. DWV-ABS cements had MEK as their primary ingredient. Bulk samples were not obtained for four products.

Concentrations of antimony, copper, lead, silver, tin and zinc in bulk samples of four copper solders are shown in Appendix F. Lead was not detected in any of the samples. Samples of two flux pastes were collected but not analyzed.

Laboratory quality assurance

In 57 blank sampling media submitted for analysis along with the field samples, no analytes of interest were present above the limits of quantitation. One of two blank urine samples contained 670 µg/l of MEK. The source of MEK in this urine sample is not known.

Twenty-eight spiked sorbent tubes (12 each of charcoal and silica gel, four of ambersorb) were analyzed along with the field samples; the analysts had no knowledge of which tubes had been spiked. Exceptional agreement between spiked and measured quantities was found for THF and MEK on both charcoal and ambersorb. For CHX, the average measured value was lower that the amount spiked (charcoal, 54% recovered; ambersorb, 87% recovered); the source of this error is not known. Measured DMF quantities were somewhat variable, but average values were in good agreement with the spiked value. Comparative results for all four substances are shown in Appendix G.

For 36 of the short-term air samples collected simultaneously on both charcoal and ambersorb, both tubes were analyzed for THF, MEK, and CHX. Twenty-two of these were collected at the beginning of the study and 14 matched charcoal-tube samples collected during high-exposure periods. Comparative results for THF and MEK are shown in Appendix G. Data derived from the two sorbent tubes were in good agreement, with no significant difference between two sorbents (paired t-test, $p=.28$ for THF; $p=.77$ for MEK). CHX was collected more efficiently on ambersorb than on charcoal.

An additional check on data quality was afforded by the comparison between 15-min solvent samples and corresponding 4-hour samples for individual workers. The general results of this comparison are presented later. However, one worker (site 14b, worker 34) was found to have an implausible disparity between the two sample types (for THF, 4-hour sample was 121 ppm; five 15-min samples, all in stratum IIIa, had a mean of 0.8 ppm). Another worker, working in the same enclosed area at the same time, had much higher 15-min samples, (mean 41 ppm) typical of the exposure category. Therefore, an equipment malfunction was suspected. All short-term sampling results for site 14b, worker 34 were excluded from further analysis. By chance, the pump was not used again for solvent sampling.

Replicate analyses of urine samples for THF, MEK, and CHX showed good reproducibility (average relative standard deviation, 11%). Among four urine samples spiked with MMF, the substance was detected in only one, but the quantity spiked (0.009 mg/ml) was slightly below the analytical limit of detection (0.01 mg/ml).

Dimethyl formamide

Airborne DMF was measured in full-shift samples collected on 28 worker-days. DMF was detected in three of the samples at concentrations of 0.1 to 0.4 ppm (mean 0.23 ppm), reflecting 8-hour TWA exposures of 0.1 to 0.3 ppm (mean 0.19 ppm). An additional three samples had DMF present, but below the analytical limit of quantitation (0.05 mg/sample), and no DMF was detected in the remaining 22 samples. The 8-hour TWA exposures represented by these samples were less than 0.01-0.03 ppm. For the days monitored, the average DMF exposure was 0.03 ppm (8-hour TWA), with two short-term samples (concentrations less than 1-7 ppm) were excluded. The probability that airborne DMF exposure would exceed the exposure limit on a randomly-selected work day was not estimated, because of the low concentrations and the small number of samples in which DMF was detected.

MMF was analyzed in 26 urine samples. In all samples, MMF concentrations were below the analytical detection limit (0.01 mg/l). Creatinine concentrations ranged from 0.8 to 3.4 mg/l (normal values are 0.5 to 3 mg/l). Thus, all urine MMF concentrations were less than 12.5 mg_{MMF}/g_{creat}, 31% of the established biological exposure index (40 mg_{MMF}/g_{creat}). DMF, not normally found unmetabolized in urine, was not detected in any urine samples, indicating that no samples had been significantly contaminated with DMF-containing products.

THF, MEK, CHX, and ACE

Short-term exposures

Concentrations of THF, MEK, CHX, and ACE were measured in 193 short-term (15-min) air samples (excluding five samples, as described in the quality assurance section). Table 4 shows the installations (CPVC-pw, etc.) and sampling strata (I-IIIb) in which the samples were collected, and Table 5 shows the percentage of total work time monitored for each category. The sampling frequency was close to the specified goals (50% of total time in strata IIb and IIIa; 100% of time in IIIb). Air flow in work areas during monitoring was 0-500 ft/min (median 30 ft/min); the distribution is shown in Figure 1. The temperature in work areas during monitoring was 13-39 C (56°-102° F, median 74° F), with the distribution shown in Figure 2. During the pipe installation periods monitored (excluding prefabrication operations), workers cemented 0-18 joints (median 4 joints). Workers were able to

complete CPVC-pw joints the most rapidly, with a median of eight per 15-min period. In special pre-fabrication setups, workers completed up to 102 joints per 15 min. The distribution of the number of joints cemented in each monitoring period is shown in Figure 3.

The highest measured 15-min exposures were to THF, up to 529 ppm (211% of the exposure limit). Of these, six exceeded the short-term exposure limit of 250 ppm. Maximum concentrations of other solvents were: MEK, 95 ppm (32% of the exposure limit); CHX, 7 ppm (13% of the exposure limit); and ACE, 208 ppm (21% of the exposure limit). %STEL values, reflecting combined exposure to theses four solvents, ranged from 0.6% to 221%, and were often dominated by the THF concentration. The additive short-term exposure limit was exceeded (%STEL>100%) in six samples. CHX concentrations were below the analytical limit of quantitation in 275 samples (92%), and products labelled as ACE-containing were used by only 17 plastic pipe workers (28%) at eight sites, thus limiting the data analysis for CHX and ACE.

Average exposure levels for the four installations and five sampling strata are shown in Table 6. The highest mean THF exposures occurred at sites where CPVC-pw was installed in enclosed spaces (174 ppm in IIIa; 139 ppm in IIIb). These categories also produced the highest mean %STEL values (IIIa, 80%; IIIb, 71%). The highest mean MEK exposures occurred during installation of DWV-ABS or of CPVC-pw pipes in enclosed spaces (25 ppm in DWV-ABS/IIIb; 20 ppm in CPVC-pw/IIIb). Analysis of variance of (log-transformed) exposure levels indicated significant differences among installation types (THF, $p<.0001$; MEK, $p<.01$) and among sampling strata (THF, $p<.01$; MEK, $p<.05$). Within the strata, exposures were significantly higher (THF, $p<.05$) when workers had secondary exposure from other workers cementing nearby, but were not significantly affected by the presence or absence of spills (THF, $p>.2$).

Working conditions that led to the highest measured 15-min THF and MEK exposures are shown in Table 7. Many of the highest THF exposures occurred during extended work in three highly-enclosed areas: two low (1-2 meter) crawl spaces where CPVC-pw and DWV-PVC were being installed concurrently, and an enclosed attic where CPVC-fire sprinklers were being retrofitted. Of the six samples in which THF exposures exceeded the short-term exposure limit, three were for workers installing DWV-PVC pipe (at a site classified as CPVC-pw because both were installed concurrently); two were for workers installing CPVC-pw, and one was for a worker installing CPVC-fire. The highest MEK exposures occurred in these same areas, and in two DWV-ABS prefabrication shops.

For the highest-exposure sites (17a and 14c), the time sequence of exposures is shown in Figure 4. At both sites, during both the morning and the afternoon, exposures increased throughout the work period. These increases over time suggest that these enclosed areas functioned approximately as closed systems,

with concentrations rising steadily as solvents evaporated from the joints cemented. In the area with the highest exposures (17a, morning), a spill (approximately 200 ml) occurred near the beginning of the work period and probably contributed to the high exposure levels. Analysis of variance among three workers in three crawl spaces (17a morning, 17a afternoon, 23 afternoon) indicated that exposures differed significantly between workers ($p<.05$) but did not differ with the type of pipe (CPVC-pw vs. DWV-PVC) being installed during monitoring ($p>.5$). The worker with the highest exposures consistently dripped more primer and cement on himself than did other workers.

Table 8 shows the estimated probability that the short-term exposure limits (for THF, MEK, and %STEL) would be exceeded in randomly-selected 15-min periods within each type of installation and sampling stratum, based on the calculated parameters of the exposure distribution. In general, these exceedance probabilities were highest in the categories that had the highest mean exposures. For THF, the exceedance probability was highest during installation of CPVC-pw pipe (IIIa, 20%; IIIb, 17%). For %STEL, the pattern was similar with slightly higher probabilities (CPVC-pw: IIIa, 25%; IIIb, 23%). The estimated probability of exceeding the MEK short-term exposure limit was 1% for CPVC-pw stratum IIIa, and much lower for all other categories. With the exceedance probabilities for each category weighted by the amount of time worked in that category, the exceedance probabilities for randomly-selected 15-min periods ranged from 0.001% for DWV-PVC to 3.5% for CPVC-pw, based on the combined exposure index %STEL.

For a hypothetical CPVC-pw installation worker, on a work day reflecting the average amounts of time spent in the various sampling strata by all CPVC-pw workers monitored (I, 42%; IIb, 10%; etc.), and whose exposures during each 15-min period were randomly drawn from the corresponding exposure distribution, the estimated probability that the short-term exposure limit would be exceeded at least once in an 8-hour day is 66% for THF, 5% for MEK, and 68% for %STEL. Similarly, the probability that two or more short-term overexposures (%STEL greater than 100%) will occur during the hypothetical work day is 31%. Of course, this estimated exceedance probability for an average workday (with samples randomly drawn from the exposure distribution) does not necessarily reflect the experience of individual workers; rather, it reflects the experience of the average worker. Analysis of variance among CPVC-pw samples indicated that exposures were not randomly distributed among workers but that there were significant differences between workers ($p=.02$ to $.04$ for various sampling strata). For the categories with adequate data, between-workers variability accounted for a substantial portion of total exposure variability (THF, 37-95%; MEK, 17-89%). Significant between-worker differences were found in all installations and sampling strata. This suggests that individual working conditions, tasks, or work practices differed substantially among the workers monitored.

Multiple regression modeling revealed significant associations between THF exposures during CPVC-pw installation and two job factors: air flow rate and ambient temperature. Two other factors (concentration of THF in the bulk products and number of joints cemented) were not significantly associated with exposure. For all installation types together, THF exposures were significantly associated with air flow rate and with bulk THF concentrations, but not the other factors tested. The coefficients and partial correlations for the four significant factors are shown in Table 9. Together, these factors accounted for a large portion of the variability among exposure levels (CPVC-pw, r^2=.57; all installation types, r^2=.59). The regression coefficients for the effects of air flow rate and bulk THF concentration were very close to the expected values (for all installations, b_V=-0.90; b_B=1.03). Figure 5 shows the conditions which produced the measured exposure levels for each factor individually. Similar associations between exposure levels and various job factors were also found for MEK , except that the number of joints cemented was significantly associated with exposure levels for both CPVC-pw and all installation types grouped. Coefficients and partial correlations for MEK are also shown in Table 9. For both CPVC-pw and all installation types, there was a strong association between THF and MEK exposures within individual periods (data not shown).

Real-time exposure profiles were obtained for 11 workers at six sites. This data provided a useful qualitative assessment of solvent exposure. Subjectively, the number of exposure peaks matched closely the number of fittings cemented, and peaks tended to be broadest (exposures dissipated slowest) in areas of low air movement. A representative detector trace is shown in Figure 6. For three 15-min periods, real-time exposure data could be directly associated with 15-min average values from a sorbent-tube sample. The real-time exposure data are summarized in Table 10. Although the 15-min averages were all less than 100 ppm (27-66 ppm), the top 5% of the 12-sec concentrations were much higher (130-235 ppm). Overall, the highest peaks (12-sec averages) were three to five times the 15-min average.

Full-shift exposures—air monitoring

Full-shift average exposures to THF, MEK, CHX, and ACE were assessed with passive monitors (mean duration 226 min) on 60 workdays. During the monitoring periods, workers cemented up to 232 joints (median 20). Daily high temperatures were 16-39° C (61-102° F, median 76° F). Air movement varied widely throughout the workdays with average air flow rates of 21 to 70 ft/min (median 46 ft/min).

Work activities during the 4-hour passive monitoring periods matched closely the entire days' work activities. For example, workers cemented an average of 0.18 joints per minute during the monitoring periods compared with 0.16 joints per minute for all on-site work time. Individual's work

rates during monitoring periods and overall were strongly correlated (r^2 = .92), as shown in Figure 7. These data indicate that work activities during the 4-hour monitoring periods were representative and helps confirm the assumption that measured 4-hour TWA exposures represent closely workers' full-shift exposures.

Among the 4-hour solvent samples representing full-shift exposures, none exceeded the full-shift exposure limits for each substance. However, the index of combined exposure (%FSEL) exceeded the limit for one worker (mean for all workers 20%, maximum 107%). As with the short-term samples, the highest exposures were to THF (mean 26 ppm, maximum 158 ppm); these dominated the combined exposure index. MEK exposures were lower (mean 6 ppm, maximum 45 ppm). CHX and ACE exposures were still lower, and generally contributed little to the %FSEL. Exposure levels to THF and MEK were strongly correlated; workers with high THF exposures tended to also have high MEK exposures. Exposures varied significantly among the four types of pipe installation. Overall, average exposures during CPVC-pw installation (mean %FSEL, 36%), were 1.8-8.5 times the average exposures during other pipe installation. Mean exposures for each installation and each substance are shown in Table 11, along with the associated geometric standard deviations.

Working conditions that led to the highest exposures are shown in Table 12. The sites and workers with the highest TWA exposures were generally the same as those with the highest short-term exposures. Of these, all had substantial amounts of work in enclosed areas, especially crawl spaces and attics. In the crawl spaces where the highest exposures were documented, workers installed both CPVC-pw and DWV-PVC concurrently.

Although no full-shift overexposures to THF, MEK, CHX, or ACE were documented, and %FSEL exceeded 100% for only one worker, the calculated parameters of the exposure distribution can be used to estimate the probability that overexposures will occur during randomly-selected work days. These probabilities are shown in Table 13. The highest probabilities were for CPVC-pw installation (THF, 5.5%%; MEK, 2.2%; %FSEL, 10.0%). Day-to-day exceedance probabilities for individual workers would be higher or lower, depending on specific site characteristics and work practices.

Multiple regression modeling revealed significant associations between full-shift THF exposures (all installation types) and three job factors: air flow rate, concentration of THF in the bulk products, and ambient temperature. Regression coefficients and partial correlations are shown in Table 14. The association between job factors and exposure levels was weaker for the full-shift data than for the short term data (THF, r^2=.33). Figure 8 shows the working conditions (joints cemented and ambient temperature) that produced the measured THF exposures. Associations between full-shift MEK exposures and various job factors were similar, except that exposure levels were also significantly

associated with the number of joints cemented, mirroring a similar result for the short-term data. Regression coefficients for the effects of air flow rate and bulk THF concentration closely matched the expected values (b_V=-1.27; b_B=1.17).

Average full-shift TWA exposures were also estimated from the average short-term exposures for each installation type and sampling stratum, weighted by the amount of time worked in the strata. The results are shown in Table 15. Average full-shift exposures estimated by this method were lower (by 8-60%) than the TWA exposures measured by passive dosimeters.

Figure 9 shows the 4-hour exposures of individual workers, as measured by passive monitors and as estimated from worker-specific 15-min exposure data for the same period. Again, the exposure levels measured by passive monitors were higher than the estimates based on short-term data. Detailed evaluation of the samples with the greatest discrepancies revealed that nearly all were collected in an enclosed attic (sites 14a, 14b), where the slow pace of work typically caused work activities to alternate between stratum I (no cementing) and stratum IIIa. Fifteen-min exposure levels were high during IIIa periods but no samples were collected during the stratum I periods. High exposures probably continued during the stratum I periods, which would be reflected in the passive-monitoring samples but would not have been included in the estimation process based on short-term samples.

Full-shift exposures-urine monitoring

End-of-shift urine samples were collected and analyzed for 61 worker-days; 53 of these were paired with passive-monitor air samples. Concentrations of THF in urine ranged from less than the detection limit to 6700 µg/l (mean 452 µg/l); no BEI has been established. MEK concentrations were up to 950 µg/l, (48% of the established BEI); the average concentration was 180 µg/l. Urine CHX concentrations were below the limit of quantitation (200 µg/l) in all samples. Urine THF and MEK concentrations were significantly different among the installation types (analysis of variance, $p<.001$ for both THF, MEK). CPVC-pw workers had the highest average urine concentrations of both THF and MEK; the averages for all groups are shown in Table 16. Working conditions for individuals with the highest urine THF and MEK concentrations are shown in Table 17, and are similar to those that produced the highest airborne exposures.

Among all samples, urine THF concentration was significantly and positively associated with airborne THF exposure (r^2=0.65). However, the relationship between urine and air THF concentrations was stronger when the samples were divided into groups according to the level of skin contact (Heavy/Light) during the last four hours before urine samples were provided (Heavy, r^2=.82; Light, r^2=.87). Figure 10 shows the relationship for each group. The slopes of the best-fit regression lines are

significantly different (analysis of covariance, $p<.01$ for log-transformed data). Relative to their airborne exposure, workers in the Heavy skin-contact group had nearly four-fold higher urine THF concentrations than did workers in the Light skin-contact group. These data strongly suggest that dermal absorption contributed to higher total exposures and higher urine concentrations in the Heavy skin-contact group. The relationship between urine and air THF concentrations for six workers who wore gloves was not significantly different than that of the Heavy or Light groups.

Four workers (14%) in the Heavy skin-contact group had urine THF concentrations that were higher (1.4 to 6.7-fold) than any in the Light skin-contact group, even though their airborne exposures were comparable. The best-fit relationship between urine and air THF concentrations for the Light group would have to be extrapolated out to airborne exposures of 150-740 ppm before urine concentrations of that magnitude would be expected.

Urine MEK concentrations were also significantly correlated with airborne MEK exposures measured by passive dosimeters, although the association was weaker than that found for THF ($r^2=.54$). With the data split by level of skin contact, workers in the Heavy skin-contact group had higher urine MEK concentrations, relative to their airborne exposures, than workers in the Light group, but the slopes of the regression lines were not significantly different (Heavy, 24 μg/l/ppm; Light, 16 μ/l/ppm). Both are within the range of previously reported values (9.4 μg/l/ppm [8,9] to 26.3 μg/l/ppm[10]). Data for both groups are shown in Figure 11. Differences between the apparent dermal absorption of THF and MEK could be accounted for in two ways. First, THF may have greater skin permeability than does MEK, but this has not been independently tested. Second, the lower concentrations of MEK in the bulk products may have made skin contact with those products relatively unimportant for dermal absorption of MEK.

CPVC, PVC, and ABS dust

No workers used saws for CPVC-pw or CPVC-fire installation. One worker used a high-speed abrasive cut-off saw to cut short lengths of CPVC pipe for prefabrication into fire-sprinkler head assemblies. Two samples—one of total particulates and one of respirable particulates—were collected simultaneously, and included the entire exposure period. The worker's 8-hour TWA exposure—presumed to be mainly CPVC dust—was 0.1 mg/m^3, of which 30% (0.03 mg/m^3) was respirable. One worker sawing DWV-PVC and one sawing DWV-ABS had total respirable particulate exposures of 0.04 mg/m^3 and 0.06 mg/m^3, respectively.

Polybutylene and flux decomposition products

Results of the GC-MS analysis of the semi-volatile fraction obtained during one PB fusion and two copper soldering operations are shown in Table 18. The only one of the EPA's 82 priority pollutants present was 2-chlorophenol which was found at a level of 0.1 $\mu g/m^3$ (near the detection limit) in one copper soldering sample and the accompanying background air sample. Another sample, collected at the same time and on the same worker, showed no 2-chlorophenol. No other GC peaks were present in the samples that were not also present in one or more blanks at approximately the same level. Semi-quantitative identification of all other peaks included the following: aliphatic hydrocarbons (C_{11}-C_{13}); alicyclic hydrocarbons (C_{16}-C_{20}); BHT (an antioxidant); phenoxy-substituted organics, fatty amines (C_{20}-C_{30}), and possible fatty acids. All constituents found in the samples were also found in one or more blanks at approximately the same level, except for aliphatic hydrocarbons (25 $\mu g/m^3$) at copper soldering site 32.

GC-MS results of the volatile fraction obtained during PB fusion are shown in Table 19. Aromatic hydrocarbons, including styrene, xylenes, toluene, benzene, and ethylbenzene, were the principal constituents noted in the analysis of PB fusion decomposition products. On an 8-hour TWA basis, these constituents were present at levels approximately 200 to 85,000-fold less than accepted exposure limits for these chemical agents. Volatile fractions of both samples collected during copper pipe installation were destroyed by the laboratory during analysis.

All formaldehyde exposures (if present) were less than the analytical detection limit (0.02-0.05 ppm at copper sites, 0.17 ppm at the PB site). It is likely that the concentrations of other low molecular weight aldehydes, such as acetaldehyde and propanaldehyde, which could also be present during copper soldering and PB fusion operations, would be less than the formaldehyde concentrations.

Metal fumes

Metal fume monitoring of fifteen plumbers at nine sites was conducted during copper pipe installation. Sampling results are shown in Table 20. Average 8-hour TWA exposures for copper, tin, silver, antimony, and lead ranged from 0.2% to 4% of their exposure limits for these metals. Lead-free solder was used at all the sites. Compositions of four bulk solder samples are shown in Appendix F. Low—but detectable—lead exposures were measured for two plumbers at one site. A bulk solder sample collected at that site contained negligible lead, and there was no other apparent source. However, workers at several other sites had lead/tin solder in their trucks or tool boxes for occasional use. Animal-fat based fluxes were used at all sites except two, where zinc chloride flux was used.

Safety hazards

Numerous safety hazards were observed at all construction sites monitored. Workers frequently used chain saws and wood-boring "hole hogs" in awkward positions to cut holes for pipe to pass through and worked atop ladders that were inadequate for the task. The combination of these two types of hazards—such as a chain saw used at the top of a too-short ladder—produced a situation far more dangerous than either hazard alone. Plumbers and other trades workers on upper floors regularly dropped objects—both small and large—near workers below. Electric power supply arrangements were often haphazard. No workers had access to eye-washing facilities in case of chemical or hot flux splash, and the building's water supply generally is not functional while pipe is being installed. Most pipe installations are done with roofs already in place, but under-floor rough-in work is inevitably done in open sunlight; no workers who were monitored or interviewed wore sunscreen.

DISCUSSION

Comparison with previous studies

The principal findings of this study are generally consistent with three previous studies of plastic pipe installation.[2,3,4] Airborne DMF exposures averaged less than 1 ppm in each study, and no MMF was detected in workers' urine either in this study or in the one previous study that measured this parameter. The DMF exposures measured in this study are far below those that have been associated with acute toxicity in other industries.[16,17]

Previous studies, like this one, have found that exposures to THF, MEK, CHX, and ACE are generally low for plastic pipe installation, but that short-term overexposures occur during some tasks.[18] Work in enclosed areas has consistently been found to be most responsible for producing overexposures. The exposures reported here are in good agreement with previous findings, especially for full-shift exposures. Short-term overexposures to THF were higher and more numerous than previously reported, most likely because a greater number and range of sites were surveyed.

Few workers in this study were exposed to plastic dust, and their full-shift exposure levels were much lower than the average exposures that were associated with changes in lung function in a group of plastics-industry workers.[19]

The quality assurance samples and the paired samples collected on both charcoal and ambersorb indicate that MEK and THF are well-collected by both sorbents, and that they suffered little degradation during storage and handling. This differs from a previous finding that MEK rapidly degrades on charcoal.[20] The facts that samples were cooled immediately after collection, and then kept frozen until analyzed, probably account for the difference. The discrepancies between measured 4-hour exposures (based on passive-dosimeter samples) and estimates based on 15-min sorbent-tube samples are comparable to previously reported discrepancies, even for passive-monitor and sorbent-tube samples collected simultaneously.[21]

Study limitations

This study had several limitations which should be considered when interpreting its results. The most fundamental of these limitations was that the scope of the study was limited to residential installations. Most plumbers do many types of installations during their careers at a mix of residential, commercial, and industrial sites. Commercial and industrial installation, typified by larger pipe sizes and extensive piping systems, are likely to produce higher exposures than occur in residential work.

Conclusions about the possible hazards of installing residential plumbing do not directly apply to the hazards faced by these same workers at other sites.

Every reasonable effort was made to include a broad spectrum of installation sites, and to monitor enough sites that all common practices in the industry would likely be included. The resulting characterization of exposures is more comprehensive than is available for most industries. Still, the fact remains that the numbers of sites and contractors included in the study are small compared to the statewide totals. Some work practices or conditions that are usual in the industry may have been missed by the study. However, overall conditions were roughly similar at many sites, suggesting considerable uniformity among sites. Workers were asked about conditions at other residential installation sites but did not report any practices that were not observed at the sites monitored.

The sites selected for monitoring were not a truly random sample, in the manner that could be achieved if sites were selected from a large pool of suitable sites. The difficulty of locating sufficient appropriate sites, especially sites where uncommon materials were being installed, left little leeway for true randomization. Often, specific sites were selected to meet the scheduling needs of the study team; this selection method would not be expected to introduce any systematic bias to the exposure levels encountered. Other sites were selected according to defined criteria, possibly biasing the results. For example, several sites with DMF use were sought (to increase the amount of DMF exposure information available), so the mean DMF exposure measured in this study may be higher than the true mean exposure level for all installation sites.

Workers and their employers have the ability to affect exposure levels by altering their practices during monitoring. All workers monitored were asked whether any such interference had taken place, and none reported changes that significantly compromise the data. However, the possibility remains that intentional or unintentional actions could have produced unrepresentative exposure levels during monitoring.

Certain combinations of working conditions could, in principle, sometimes occur together to produce "worst-case" exposures higher than those found in this study. For example, the data presented above suggest that those might occur at a site with: no air movement, several workers in the same work space, many joints glued for a given period, heavy skin contact with primers and cements, and perhaps high ambient temperatures and a few spills of the bulk products. Two of the sites monitored (sites 14 and 17) had several of these factors, but not all of them. Sites with all the factors listed above could have higher exposures.

Applications of data

Many exposure parameters have been estimated in this study. In many cases, these parameters can be used to estimate the exposures likely to occur under conditions different than those found in this study. However, suitable caution must be exercised, as discussed below.

The average short-term solvent exposures for each installation type and sampling stratum, together with the average times worked in each category, were used to estimate average full-shift exposures. The same data could be used to calculated the expected exposure of a worker whose activities were not average. For example, a CPVC-pw worker who spent three times as much work-time as average under stratum IIIa and IIIb conditions would have an expected THF exposure of 64 ppm, compared to the 36 ppm expected for an average worker. This value is still considerably less than the highest TWA exposure measured in this study, 158 ppm THF. Using additional assumptions, expected full-shift exposures could be calculated for workers with any allotment of time in the various sampling strata, and whose exposures within each stratum corresponded to any desired percentile of the measured exposure distribution.

The statistical associations between exposure levels and various job factors help highlight patterns in the data. Overall, air flow rate (a measure of ventilation rate) was the strongest and most consistent determinant of exposure levels. Composition of bulk products was a significant determinant of exposures for all installation types grouped, but with the analysis restricted to CPVC-pw (in which bulk compositions that were relatively homogeneous), the association was no longer significant. Conversely, ambient temperature was significantly associated with exposure levels during CPVC-pw installation, but not significantly associated with all installations grouped. These data do not preclude the possibility that high ambient temperatures produce somewhat elevated exposures; rather they indicate that in this data set the temperature effect (if any) is minor compared to the effects of ventilation and bulk composition.

The observed associations between job factors and exposure levels cannot reliably be used to predict exposure levels expected under conditions not monitored in this study, particularly because several of the job factors were interrelated, decreasing the reliability of the resulting statistics. For example, the highest exposures, which dominated the exposure distribution, were collected in just two crawl spaces. Both had little ventilation, and both were partially underground and quite cool. Thus, if the overall exposure model controlled imperfectly for air flow rate (which is likely), then a misleading apparent (negative) association could appear between temperature and exposure level. This same phenomenon also applies to other job factors. Fortunately, there is little need to extrapolate the observed associations to hypothetical conditions, because the two factors which most strongly determined

exposure levels—air flow rate and bulk composition—were each encountered at relatively extreme values during this study. Specifically, exposures were monitored in areas with no ventilation, where products containing 80-85% THF were in use, leaving little room for extrapolation.

Probabilities of exceeding the applicable short-term and full-shift exposure limits during CPVC-pw installation, presented above, apply specifically to the working conditions found in this study. These exceedance probabilities are the proportion of all exposures expected to exceed the exposure limit. The estimated exceedance probabilities are 68% for %STEL and 10% for %FSEL. These were fixed mainly by the amount of time worked in highly-enclosed areas, and by the relative severity of the exposures in those areas. For workers who rarely work in such areas, the chance of their exposures exceeding the established limits is very low. Conversely, workers who spend extended periods in highly-enclosed areas may experience frequent overexposures. Two workers did, in fact, have repeated overexposures while working for several hours in a crawl space. Because the amount of work in highly-enclosed areas may be over-represented or under-represented in this study (sites with enclosed areas were specifically sought for monitoring, but few were located), the calculated exceedance probabilities may not apply to the industry as a whole.

The average daily full-shift solvent exposures reported in this study are probably higher than workers' long-term average exposures during residential plastic pipe installation, because workers are unlikely to cement joints continuously day after day. At the sites monitored, installations were frequently interrupted by poor organization, lack of supplies, or building inspections; workers would then be assigned to test for leaks, drill holes, or other tasks. Exposures on such days were not monitored and thus are not included in the results. Workers who also install industrial plastic-pipe systems may have higher long-term exposures.

Four workers in the Heavy skin-contact group with the highest THF exposures (80-160 ppm) had urine THF concentrations of 1400-6700 µg/l. These values would be expected in the Light group only after airborne exposures of 150-740 ppm; and the difference was attributed to dermal absorption. Based on a model that the best-fit line for the Light skin-contact group represents the true relationship between airborne THF exposures and urine THF concentrations, these concentrations (150-740 ppm) can be considered estimates of equivalent airborne exposure. Calculation of these equivalent airborne exposures is based on extrapolating far beyond any measured values the relationship between airborne and urine THF concentrations found in the Light group. A conservative lower bound to the equivalent airborne exposures can be derived by extrapolating the upper 95% confidence limit (10.85 µg/l/ppm) of the best-fit slope for the Light group; this method suggests that the equivalent airborne exposure corresponding to the highest measured urine THF concentration was at least 610 ppm. These equivalent airborne exposure values should be regarded with caution, since they are based on interpretation rather

than on direct measurement. The values cannot be lightly dismissed, however, because they so far exceed the established full-shift exposure limit for THF (up to 3.7-fold), and because they indicate that dermal absorption may be an important contributor to total exposure

Health significance

Although the health effects of workplace exposures were not studied, the ultimate goal of this exposure assessment was to evaluate the possibility that the exposures could lead to adverse health impact. No airborne exposures measured in this study reached levels known to cause long-term health damage, but the existing toxicity information is extremely limited for several substances, notably THF. For some substances monitored (especially the metal fumes), the measured exposures were sufficiently lower than the established exposure limits that toxicity seems unlikely, based on present information.

The short-term and full-shift exposures to THF and MEK were highest relative to their exposure limits, so their significance is of particular interest. For both substances, the established exposure limits were set to prevent eye, nose, and throat irritation, and are much less than the levels needed to induce acute central nervous system depression. The potential for these substances to cause other types of systemic effects—especially after chronic exposure—has not been comprehensively assessed.

A particular weakness in the existing toxicity information for THF and MEK regards their ability to cause chronic neurologic effects. Some organic solvents, especially aromatic hydrocarbons, have been associated with neurobehavioral impairments (in reaction time, memory, and related parameters) in workers with long-term exposure.[22,23,24] The potential for THF or MEK to cause similar impairments has not been assessed.

Because short-term THF exposures up to twice the exposure limit were documented, some workers may experience eye, nose, or throat irritation. The brief (12-sec) exposure peaks described earlier are unlikely to have substantial health impact but are noticeable (because of the strong odors of THF and MEK) to many workers and may contribute to perceptions of intense, intermittent exposures.

Although the full-shift airborne THF exposure levels measured in this study did not exceed the exposure limit, the estimated equivalent airborne exposures, based on urine THF concentrations for four workers in the Heavy skin-contact group, were up to 740 ppm, 3.7 times the full-shift exposure limit. The health effects of dermally-absorbed THF cannot be fully assessed with the available toxicity information, but substantial dermal absorption would be expected to increase the likelihood of systemic effects from chronic exposure to THF. Overall, the highest measured urine THF concentrations suggest that some workers have total exposures that are considerably higher than the airborne exposures

reported in this study or previously. The magnitude of these estimated equivalent exposures highlights the need for better chronic toxicity data for THF.

Exposures to DMF and antimony were low in comparison with their respective exposure limits. Inconclusive evidence for each of these substances has suggested that they may cause cancer, but their exposure limits do not reflect possible carcinogenicity. If either proves to be a carcinogen, the exposures documented in this study would need reinterpretation. The possibility that carcinogenic flux decomposition products might be produced during copper soldering could not be adequately evaluated, because the volatile fraction was lost in analysis.

CONCLUSIONS

The following conclusions apply only to residential pipe installation under conditions similar to those observed in this study, which were believed to have been representative of the industry as a whole. Substantially different working conditions could produce exposures for which these conclusions are not valid. [This caveat must be included when citing any of the following conclusions.]

1. Short-term exposure limits for THF, and for the additive effects of THF, MEK, CHX, and ACE, are sometimes exceeded during routine residential plastic-pipe installation. The probability of exceeding the short-term exposure limits at least once in a work day is dependent on working conditions and is highest for workers installing CPVC potable water pipe; for these workers, this probability is estimated to be 68%.

2. Full-shift exposures to THF, MEK, CHX, and ACE did not exceed the respective exposure limits for any worker monitored in this study. However, the combined exposure limit (%FSEL) was exceeded (107%) for one worker, indicating that full-shift overexposures occur on some work days. Overexposures are most likely to occur during CPVC-pw installation, in which the probability of overexposure is estimated to be 10%.

3. Conditions most likely to produce the highest short-term and full-shift exposures include: extended work in highly enclosed areas such as attics and crawl spaces, several people working in the same enclosed area, many joints cemented in a short period, and excessive application of primers and cements, leading to spills and heavy skin contact.

4. Exposures to airborne THF, MEK, CHX, and ACE at the levels measured in this study may produce eye, nose, and throat irritation. They are not known to produce any long-term health effects, but for some of these substances (notably THF) the health effects of long-term exposure have not been studied.

5. Dermal absorption of THF probably contributes significantly to the total (airborne plus dermal) exposure of workers who have heavy skin contact with primers and cements. Based on their urine THF concentrations, four of these workers had estimated equivalent airborne exposures ranging from 150 to 740 ppm. Despite the uncertainty of these estimated values and the lack of chronic toxicity information, these data are of concern because they suggest that for some workers, total exposure may far exceed the airborne exposure limit.

6. DMF exposure, both airborne and total (airborne plus dermal, measured by urine MMF), is below the established exposure limits during cementing of plastic pipes.

7. Exposure to plastic dusts is uncommon during plastic pipe installation and is far below the concentrations that have previously been associated with changes in pulmonary function in other industries.

8. Metal fume exposures during copper pipe soldering (with lead-free solder) are far less than their established exposure limits.

9. Thermal fusion of small-diameter PB pipe joints produces low levels of several hydrocarbons and oxygenated hydrocarbons, but the concentrations were far below those shown to produce toxicity.

10. The potential toxicity of flux decomposition products produced during copper soldering was not evaluated, because samples were irretrievably damaged during analysis.

11. Pipe installation workers face a variety of safety hazards including: chain saws and wood-boring tools used in awkward positions, unsafe ladders, and objects falling from above.

12. Few workers have received adequate training in the spectrum of hazards that they routinely encounter on construction sites, or in safe work practices.

RECOMMENDATIONS

Data in this study indicate that workers cementing plastic-pipe joints are sometimes overexposed to substances contained in the primers and cements, and that overexposures are most likely to occur during work in highly-enclosed areas or when workers have heavy skin contact with primers and cements. To prevent such overexposures, the following recommendations should be implemented consistently throughout the construction industry. Each of the recommendations are technically feasible, and all have been adopted successfully in other industries.

1. Contractors and workers should attempt to arrange their work so that little plastic pipe cementing is required in highly enclosed areas such as crawl spaces and attics.

2. When cementing in highly-enclosed areas is necessary (for example, when repairing plumbing or remodeling), employers should provide portable fans to prevent short-term and full-shift overexposure to substances in the primers and cements.

3. Employers should establish and enforce work practices that minimize skin contact with primers and cements. Two practices should be specifically prohibited: cleaning hands with primer, and wiping excess cement from joints. Workers who cannot follow these practices should be provided with protective gloves and required to wear them.

4. Plumbing contractors should provide portable emergency eyewash facilities for all employees, because splashes of plastic pipe primers and cements or of hot flux could produce serious eye damage, and this damage could be reduced by immediate flushing. Portable eyewash stations could be installed on contractors' trucks, which are kept as close to the worksite as possible.

5. Plumbing contractors should provide health and safety training for all employees. This training should include: ladder safety, safe use of chain saws and wood-boring tools, hazards associated with other construction trades, and the potential hazards and safe use of plastic pipe primers and cements.

The following recommendations should be implemented by chemical manufacturers and formulators who supply products used in plastic-pipe installation.

6. All primers and primer/cleaners should be strongly tinted in bright colors, to discourage their use as hand cleaners.

7. Because of its greater toxicity, DMF should be replaced in primers and cements by THF, MEK, CHX, or ACE whenever practical, even though the DMF exposures measured in this study were below the established limits.

8. Information about the health effects of THF exposure should be improved by conducting appropriate tests on the acute and chronic toxicity of THF, including its potential to produce neurologic effects.

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TABLES

Table 1. Plastic pipe installation sites selected because they were believed to have specific workplace conditions that had not been encountered at previous sites.

Criterion	Sites selected
Apartments/Townhouses	11, 12, 13, 16, 17, 18, 31
High Temperatures	8, 9, 11, 12, 13
Use of DMF	14, 18, 22, 31
Enclosed	9, 11, 13,
Work in crawl spaces	14, 17
Cross-exposures (i.e. CPVC/PVC)	17, 23
Remodels	14
Unusually high number of workers	8
Repeat site visits	8b, 13b, 14b, 14c, 16b, 17b, 22b
Prefabs	7,9,35

Total chosen for specific criteria: 14

Table 2. Average proportion of total on-site work-time spent in each sampling stratum, for workers in each installation type. All values are percentages.

Sampling stratum	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
I	42%	50%	56%	48%
IIa	34	28	40	12
IIb	10	1	1	31
IIIa	13	20	2	3
IIIb	1	2	1	7

Table 3. Prevalence of symptoms reported by workers for days monitored.

Symptom	Percent reporting
None	51%
Any symptom	31
irritation of eyes, nose, or throat	10
dizziness	9
dried skin	9
headache	8
skin rash	7
gastrointestinal disturbances	4
other	2
Not reporting	19

Table 4. Number of short-term solvent samples collected for each installation and sampling stratum.

Sampling stratum	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
I	0	5	0	1
IIa	10	18	7	3
IIb	23	5	1	18
IIIa	20	57	0	3
IIIb	3	13	1	5

Table 5. Percentage of total work time monitored, for each installation and sampling stratum. Goals established prior to monitoring were 50% of total time in strata IIb and IIIa, and 100% in stratum IIIb.

Sampling stratum	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
I	0%	1%	0%	1%
IIa	5	8	6	11
IIb	45	63	30	54
IIIa	42	50	0	44
IIIb	100	65	100	83

Table 6. Mean short-term exposures for each installation type and sampling stratum, for a) THF, b) MEK, c) CHX, d) ACE, and e) %STEL. Concentrations in ppm, and %STEL is shown as percentage of combined exposure limit.

Sampling stratum	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
a) THF				
I	—[a]	5	—	0.2
IIa	27	25	5	0.3
IIb	16	72	18	0.2
IIIa	174	30	—	0.2
IIIb	139	27	66	0.2
b) MEK				
I	—	2	—	1
IIa	2	3	1	5
IIb	8	6	0.4	15
IIIa	13	7	—	11
IIIb	20	3	0.6	25
c) CHX				
I	—	0.2	—	0.3
IIa	0.4	0.4	0.3	0.4
IIb	0.3	0.5	0.3	0.3
IIIa	1	0.5	—	0.3
IIIb	1	0.3	0.4	0.3
d) ACE				
I	—	0.5	—	0.5
IIa	7	1	2	1
IIb	6	0.5	0.5	0.5
IIIa	43	0.5	—	0.5
IIIb	77	0.5	1	0.5
e) %STEL				
I	—	3%	—	1%
IIa	13%	11	3%	2
IIb	10	32	8	6
IIIa	80	15	—	4
IIIb	71	12	27	9

[a]no samples were collected in these categories.

Table 7. Working conditions during the highest measured short-term exposures to a) THF (>200 ppm), and b) MEK (>40 ppm).

Site	Installation	Location	Joints	Temp, F°	Notes	Exposure, ppm
a) THK						
17a	CPVC-pw	crawl space	2.5	70	DWV-PVC[a]	529
17a	CPVC-pw	crawl space	4.5	71		443
14c	CPVC-fire	attic	1	77		311
17a	CPVC-pw	crawl space	3	68	DWV-PVC[a] spill	307
17a	CPVC-pw	crawl space	8	71		304
17a	CPVC-pw	crawl space	4.5	70	DWV-PVC[a]	292
23	CPVC-pw	crawl space	2	68	DWV-PVC[a]	213
17a	CPVC-pw	crawl space	1.5	68	DWV-PVC[a]	209
b) MEK						
14c	CPVC-fire	attic	1	77		96
17a	CPVC-pw	crawl space	4.5	71		53
7	DWV-ABS	prefab shop	102	71		49
35	DWV-ABS	outdoor,prefab	32	59		45
16b	CPVC-pw	interior	16	76		42

[a]these workers also installed DWV-PVC during at least part of the monitoring period.

Table 8. Estimated probability (based on parameters of exposure distribution) that short-term exposure limits would be exceeded in randomly-selected 15-min periods, by installation and sampling strata. All values are percentages.

Sampling stratum	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
a) THF				
I	0.3%	0.3%	—[a]	—
IIa	2	1	0.1	0[b]
IIb	0	4	—	0
IIIa	20	2	—	0
IIIb	17	0.8	—	0
b) MEK				
I	0	0	—	—
IIa	0	0	0	0
IIb	0	0	—	0.1
IIIa	1	0.02	—	0
IIIb	0	0	—	0
c) %STEL				
I	0	0	—	—
IIa	0.7	0.8	0	0
IIb	0.02	4	—	0
IIIa	25	1	—	0
IIIb	23	0.3	—	0

[a]not estimated, because of insufficient data.
[b]values less than 0.01% were rounded down to zero.

Table 9. Associations between various job factors and the resulting short-term exposure levels, in stepwise multiple regression modeling. Coefficients (slopes) and partial correlations are shown.

	CPVC-pw		All installations	
Job factor	slope	partial r^2	slope	partial r^2
a) THF				
Air flow, ft/min	-1.05	.44*	-0.90	.16*
THF in bulk products (wt/wt)	0.90	.02	1.03	.42*
Temperature, °F	-4.91	.10*	-1.31	.004
Joints cemented	-0.23	.01	0.22	.01
b) MEK				
Air flow, ft/min	-0.74	.24*	-0.57	.13*
MEK in bulk products (wt/wt)	-0.49	.01	0.46	.14*
Temperature, °F	-1.27	.004	-0.85	.004
Joints cemented	1.54	.17*	0.50	.13*

*significantly associated with exposure level ($p<.05$)

Table 10. Total photoionizable organics, measured in real time by photoionization detector, for three representative sampling periods.

ID/Installation	15-min charcoal TWA (ppm)	Estimated GSD	12-sec periods with ppm>250	95th %ile (ppm)
1 CPVC-pw	50	2.2	0	133
2 CPVC-pw	26.9	2.3	0	130
3 CPVC-fire	66.4	3.3	4	235

Table 11. Mean full-shift exposures to THF, MEK, CHX, and ACE (and %FSEL) for each plastic pipe installation type. Exposures were assessed with 4-hour passive dosimeter samples. Concentrations are in ppm, and values in parentheses are geometric standard deviations.

Exposure	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
THF	47	28	5	0.3
MEK	10	6	0.8	9
CHX	0.2	0.7	0.2	0.6
ACE	16	0.6	1	0.6
%FSEL	36%(3.5)	20%(2.6)	4%(2.1)	7%(1.6)

Table 12. Working conditions during the highest measured full-shift exposures to a) THF (>75 ppm) and b) MEK (>25 ppm).

Site	Installation	Enclosed Space	Skin Contact	Experience (Years)	Temp	Notes	Exposure ppm
a) THK							
17a	CPVC-pw	Yes	Heavy	5	72	DWV-PVC[a]	158
14b	CPVC-fire	Yes	Heavy	6	80		121
14a	CPVC-fire	Yes	Light	8	88	DWV-PVC[a]	110
17a	CPVC-pw	Yes	Heavy	4	72	DWV-PVC[a]	97
17a	CPVC-pw	Yes	Heavy	10	72		96
23	CPVC-pw	Yes	Heavy	4	78	DWV-PVC[a]	84
31	CPVC-fire	No	Gloves	0	75		83
14b	CPVC-fire	Yes	Heavy	1	80		77
b) MEK							
14b	CPVC-fire	Yes	Heavy	6	80		45
23	CPVC-pw	Yes	Heavy	4	78	DWV-PVC[a]	33
14a	CPCV-fire	Yes	Light	8	88		30
14b	CPVC-fire	Yes	Heavy	1	80		27
31	CPVC-fire	No	Gloves	0	75		27

[a]these workers also installed DWV-PVC during part of the monitoring period.

Table 13. Estimated probability (based on parameters of exposure distribution) that full-shift exposure limits would be exceeded in randomly-selected work days. All values are percentages.

Substance	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
THF	5.5%	1.9%	0.02%	0[a]
MEK	2.2	0.4	0	0.09
%FSEL	10.0	1.4	0	0

[a]values less than 0.01% were rounded down to zero.

Table 14. Associations between various job factors and resulting full-shift exposure levels, in stepwise multiple regression modeling. Coefficient (slopes) and partial correlations are shown.

	THF		MEK	
Job factor	slope	partial r^2	slope	partial r^2
Air flow, ft/min	-1.27	.07*	-1.18	.03*
THF in bulk products (wt/wt)	1.17	.19*	0.70	.09*
Temperature, °F	4.74	.06*	—	<.001
Joints cemented	0.17	.01	0.45	.09*

*significantly associated with exposure ($p<.05$)

Table 15. Mean full-shift exposures estimated from short-term exposure monitoring, weighted by percentage of work time spent in each sampling stratum for each installation type. Concentrations are in ppm. Values in parentheses are percentages of comparable values derived from 4-hour passive dosimeters.

Substance	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS
THF	36 (76%)	16 (59%)	3 (50%)	0.2 (59%)
MEK	4 (40%)	3 (48%)	0.4 (54%)	8 (92%)

Table 16. Mean urine THF and MEK concentrations for each plastic pipe installation type, and number of air samples collected. All concentrations are in µg/l.

Substance	CPVC-pw	CPVC-fire	DWV-PVC	DWV-ABS	Overall
THF	1260	269	137	33	452
MEK	365	123	119	169	180
n	14	29	15	3	61

Table 17. Working conditions and airborne exposures of workers with highest concentrations of THF (>700 µg/l) and MEK (>500 µg/l) in urine.

Site	Installation	Location	Skin contact	Airborne exposure, ppm	Urine concentration, µg/l
a) THF					
17a	CPVC-pw	crawl space	heavy	158	6700
17a	CPVC-pw	crawl space	heavy	97	4200
23	CPVC-pw	under floor	heavy	84	2500
17a	CPVC-pw	crawl space	heavy	96	1400
14a	CPVC-fire	crawl space	light	110	1000
14b	CPVC-fire	crawl space	heavy	69	860
23	CPVC-pw	under floor	heavy	55	820
14c	CPVC-fire	attic	light	49	750
17b	CPVC-pw	interior	heavy	48	710
b) MEK					
23	CPVC-pw	under floor	heavy	33	960
17a	CPVC-pw	crawl space	heavy	23	950
	unexposed control			none	670
14a	CPVC-fire	attic	light	30	540
17a	CPVC-pw	crawl space	heavy	25	540
17a	CPVC-pw	crawl space	heavy	11	520

Table 18. Substances identified by GC-MS analysis of semi-volatile fraction of copper flux and PB fusion thermal decomposition products.

Installation/ Site	Constituent	Quantity detected, ng/filter	Concentration, $\mu g/m^3$
Copper Installation: site #33, sample #549 high flow (same sampling period as #548)	Aliphatic HCs.[a](C_{11}-C_{30})	1	0.006
Copper Installation: site #33, sample #548 low flow (same sampling period as #549)	Aliphatic HCs.(C_{11}-C_{30})	3	0.723
	2-chlorophenol[b]	0.4	0.096
Copper Installation site #32	Aliphatic HCs. (>C_{15})	4000	24.7
PB Fusion site #34, sample #498 high flow	Aliphatic amines(C_{11}-C_{30})	50	0.926
	Alicyclic HCs.(C_{16-18})	3	0.037
	BHT (antioxidant)	2	0.019
	Phenoxy substituted organic	1	0.019
	Fatty amines	3	0.056
	Possible fatty acids	3	0.037
Background: site #33, sample #550	Aliphatic HCs.	3	0.598
	2-chlorophenol[b]	0.4	0.080
Blank: site #33, sample #902	Aliphatic HCs.(C_{11}-C_{30})	40	NA
	Alicyclic HCs.(C_{11}-C_{30})	3	NA
	BHT (antioxidant)	1	NA
	Fatty amines(C_{20}-C_{30})	3	NA
Blank: site #34, sample #504	Aliphatic HCs.(C_{11}-C_{30})	60	NA
	BHT (antioxidant)	1	NA
	Phenoxy substituted organic	1	NA
	Fatty amines (C_{20}-C_{30})	2	NA
	Possible fatty acids	1	NA

[a]HCs=hydrocarbons [b]EPA Priority Pollutant NA-not applicable

Table 19. Substances identified by GC-MS analysis of volatile fraction of PB fusion thermal decomposition products.

Installation/ Site No.	Component	Approx. level (ppbv)
PB fusion site #34	Benzene	4.8
	Carbon tetrachloride	0.06
	Chlorobenzene	0.3
	Ethylbenzene	9.4
	Styrene	30.0
	Tetrachoroethane	0.2
	Toluene	6.0
	1,1,1-trichoroethane	2.1
	Trichloroethene	0.2
	Xylenes	19.0
Blank	—	
Background	Carbon tetrachloride	0.09
	Ethylbenzene	5.8
	Styrene	15.0
	Tetrachloroethene	0.2
	Toluene	1.7
	Trichloroethene	0.1
	Xylenes	5.2

Table 20. Average concentrations of metal fumes measured in personal air samples.

	8-hr TWA mg/m^3	GSD	Exposure Limit (mg/m3)	% of Exposure Limit
Silver	0.0004	1.94	0.01	4.4
Antimony	0.0014	1.89	0.5	0.3
Tin	0.0038	3	2	0.2
Copper	0.0018	3.2	0.2	0.9
Lead	0.0017	2.1	0.05	3.4

FIGURES

Figure 1. Air flow rate in work areas during short-term monitoring periods.

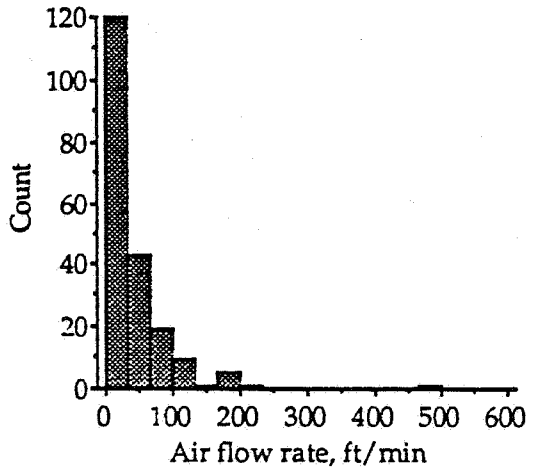


Figure 2. Temperature in work areas during short-term monitoring periods.

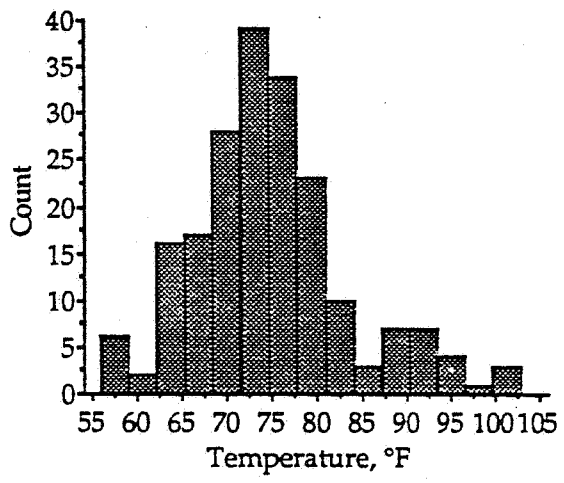


Figure 3. Number of joints cemented per 15-min period during all short-term monitoring periods.

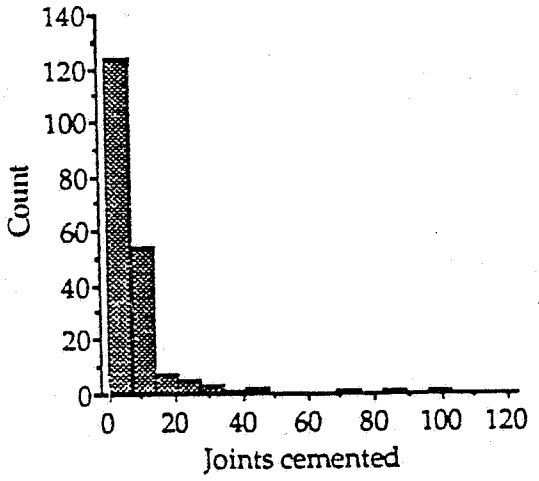


Figure 4. Time sequence of exposure levels measured in three highest exposure sites: a) site 17a, morning, b) site 17a, afternoon, c) site 14c, morning, and d) site 14a, afternoon.

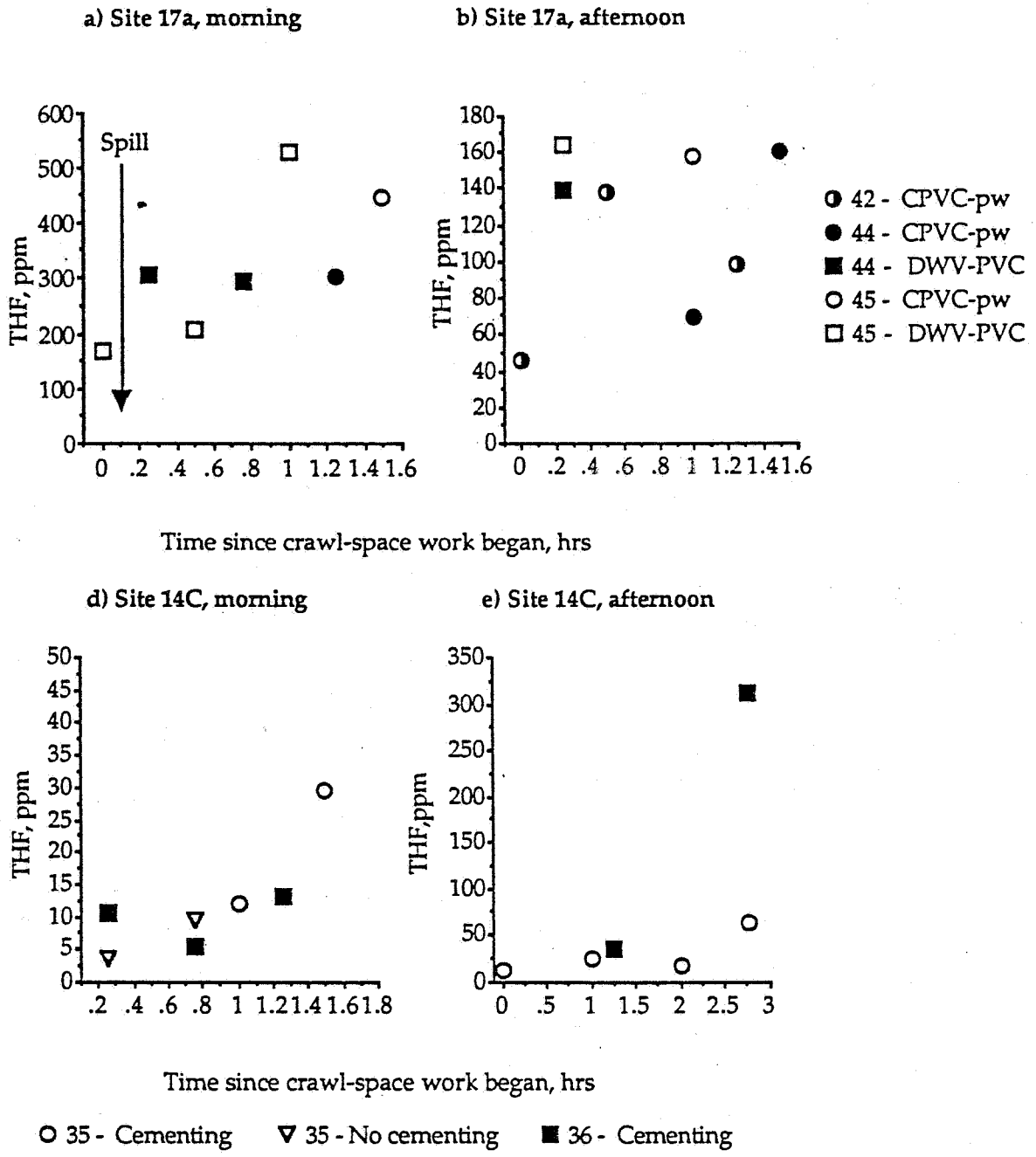


Figure 5. Relationship between short-term THF exposure during CPVC-pw installation and three job factors: a) air flow rate, b) temperature, and c) number of joints cemented in the 15-min period.

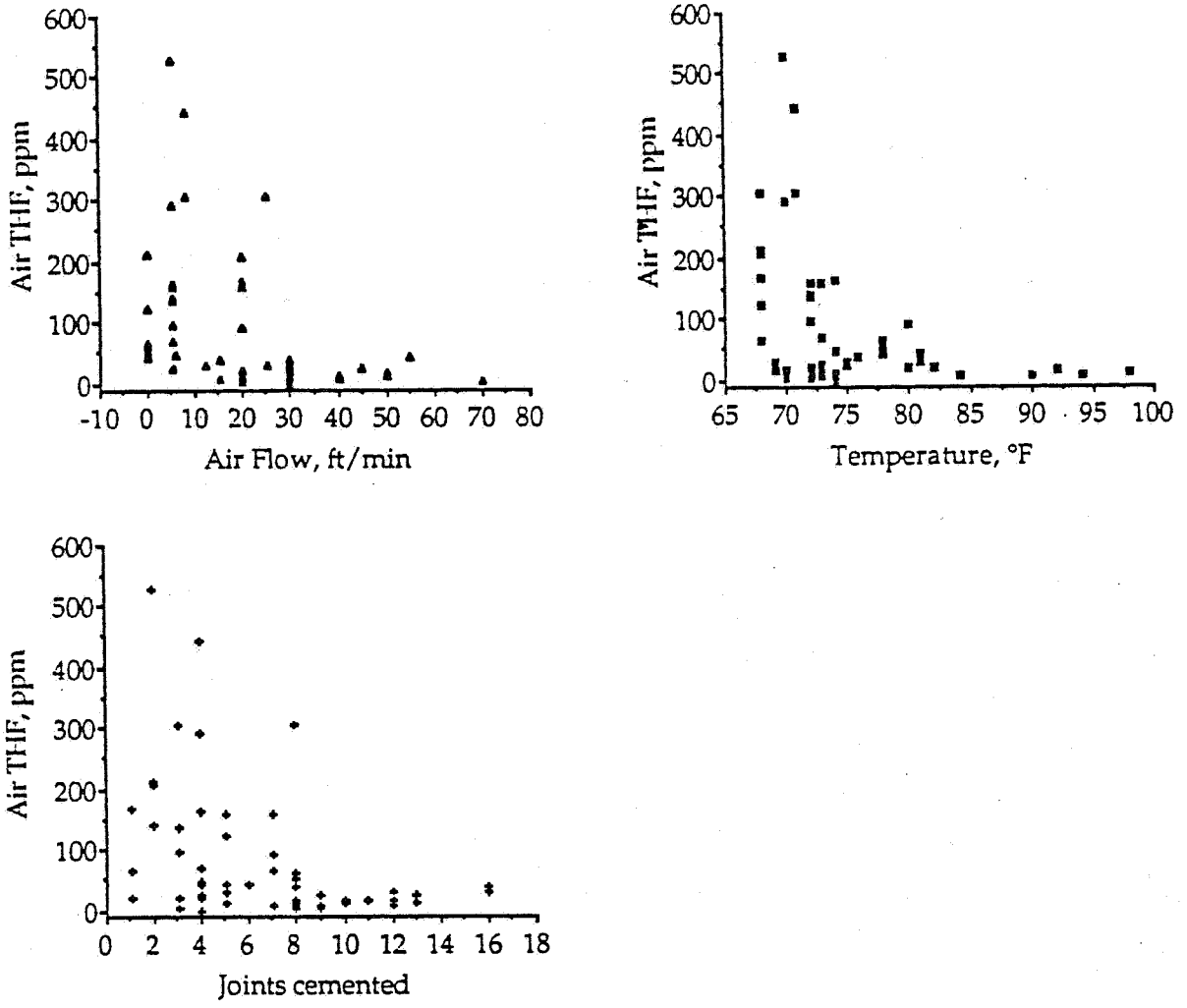


Figure 6. Real-time exposure variability during a representative 15-min monitoring period, as shown by photoionization detector trace.

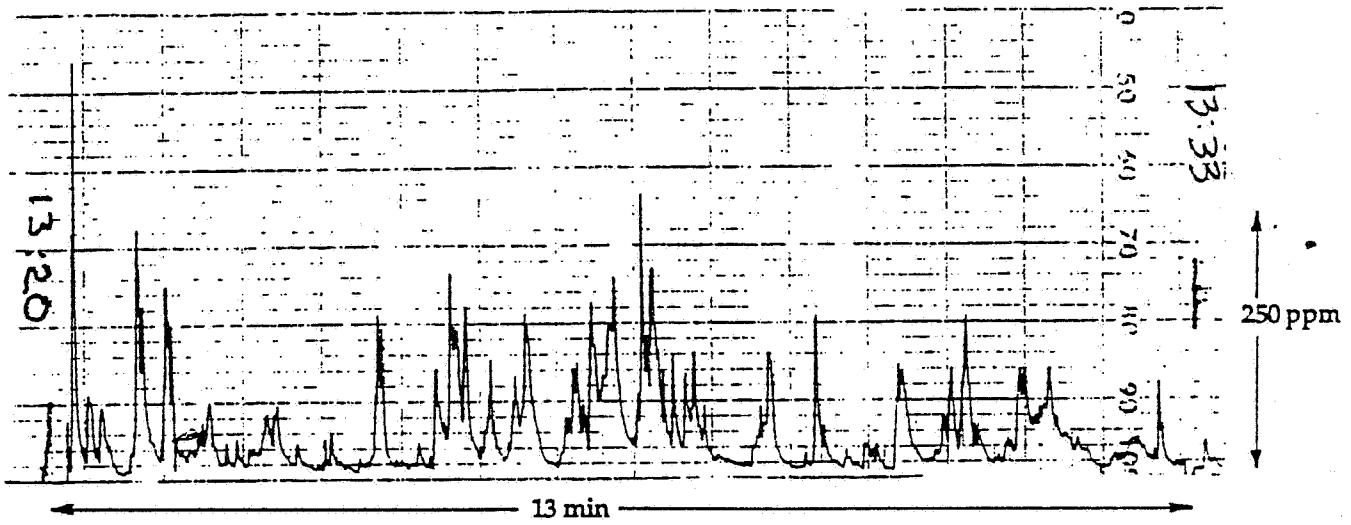


Figure 7. Individual work rates (as joints per minute) during 4-hour monitoring periods and for entire work days.

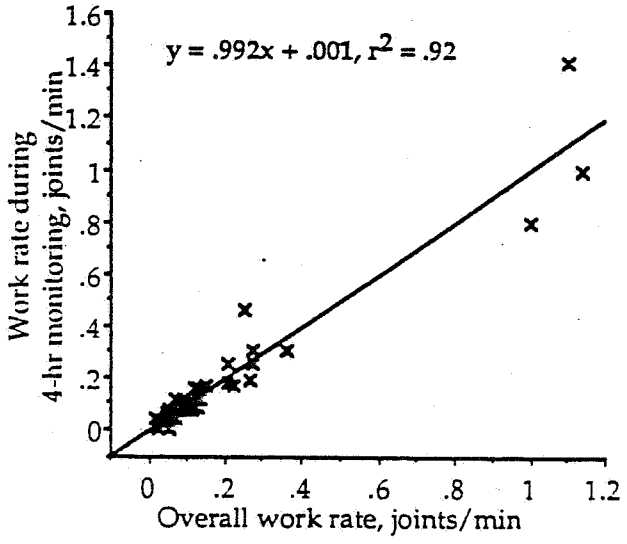


Figure 8. Working conditions associated with full-shift THF exposures: a) number of joints cemented during the monitoring period, and b) temperature.

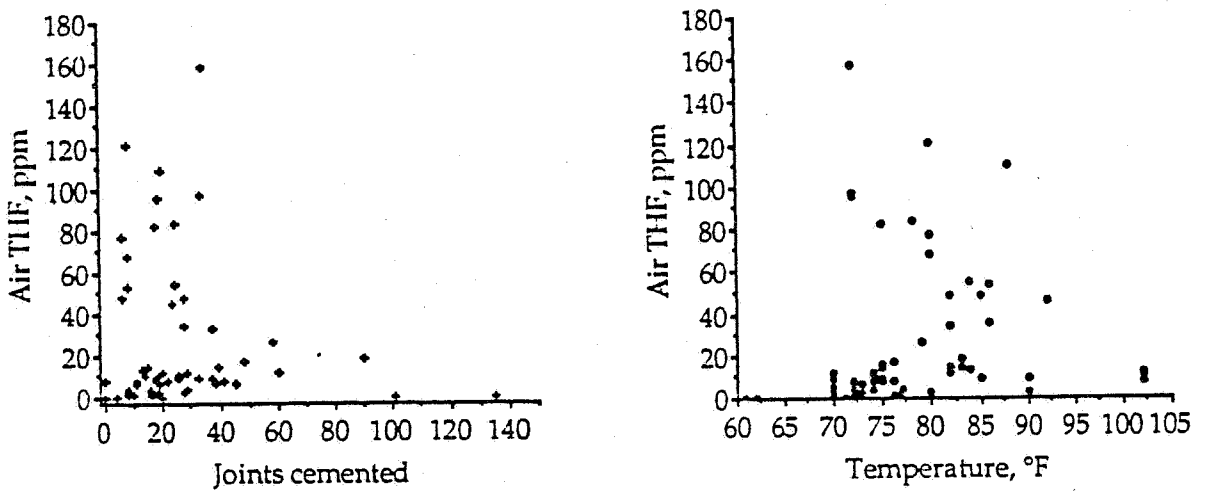


Figure 9. Four-hour exposures to a) THF and b) MEK, as estimated from time-weighted short-term exposure data and as measured by passive dosimeters. All exposures in ppm.

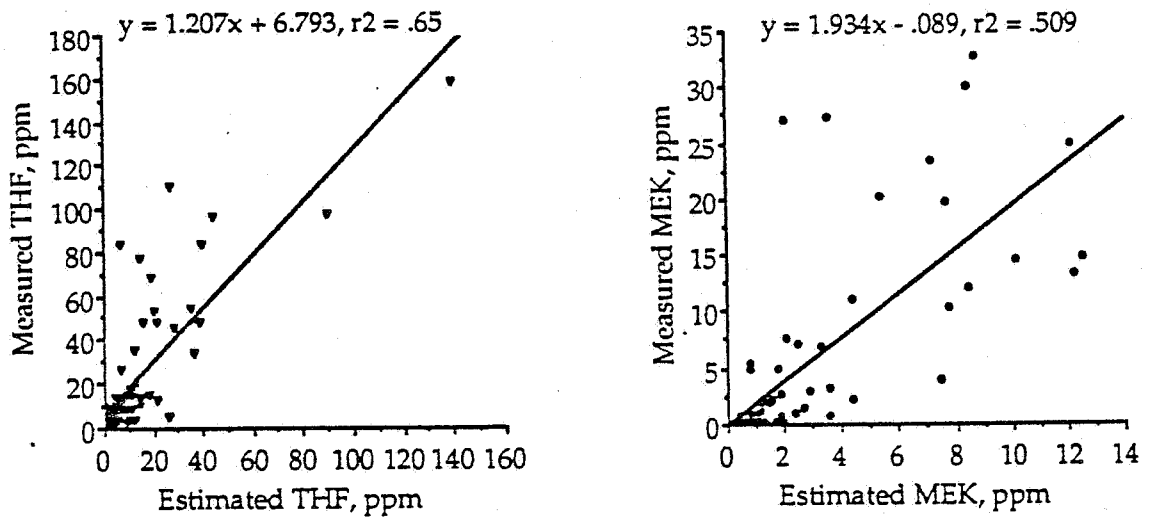


Figure 10. Relationship between urine THF concentrations and airborne THF exposures, by level of skin contact: a) Heavy, and b) Light. Best-fit regression lines are shown.

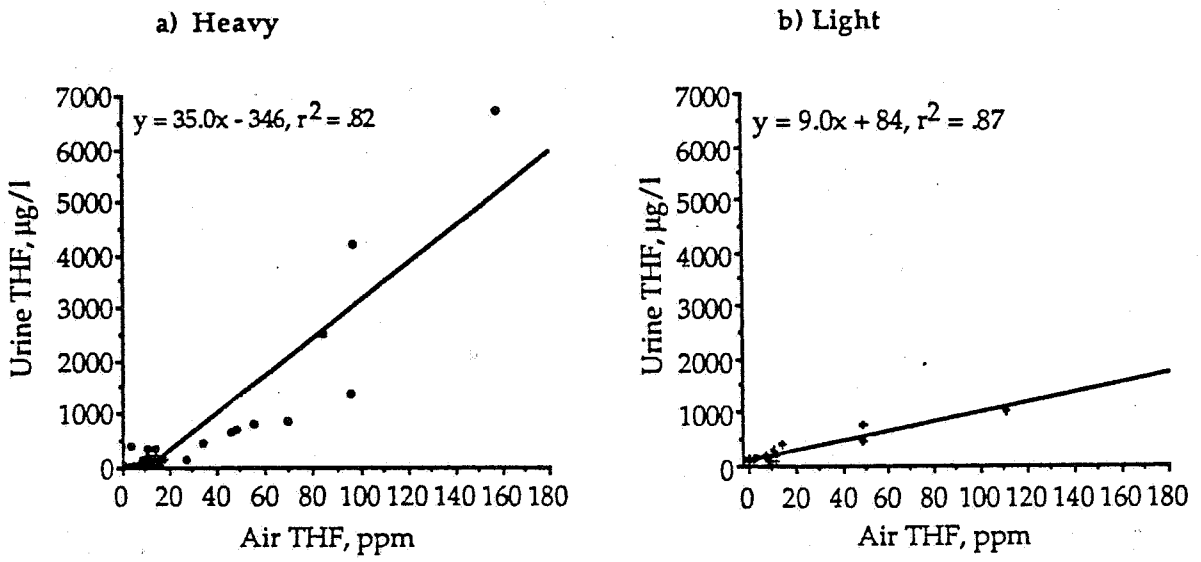
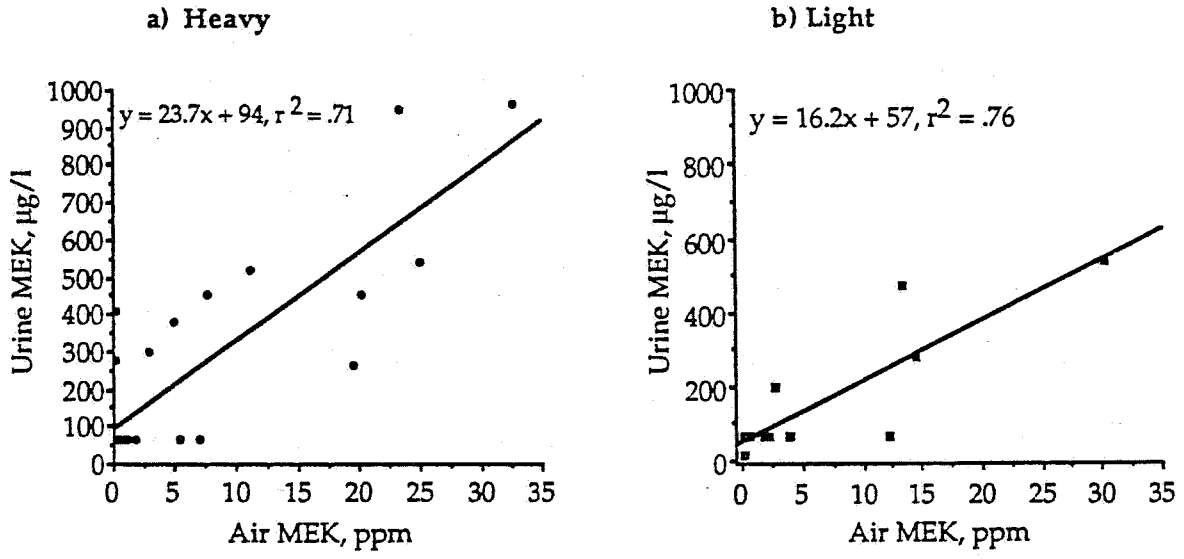


Figure 11. Relationship between urine MEK concentrations and airborne MEK exposures, by level of skin contact: a) Heavy, and b) Light. Best-fit regression lines are shown.



APPENDIX A

Air sampling and analysis methods, and typical detection limits.

Analytes	Collection media	Sampling time	Analysis	Minimum detectable exposure[a]
THF, MEK, CHX, ACE				
full-shift	passive dosimeter	4 hr	GC-FID[b]	0.2 ppm THF,MEK,CHX
short-term	charcoal	15 min	GC-FID	0.7 ppm
	ambersorb XE-347	15 min	GC-FID	0.7 ppm
DMF	silica gel	full shift	GC	0.05 ppm
Plastic Dust				
total	membrane filter	full shift	gravimetric	0.01 mg/m^3
respirable	filter + cyclone	full shift	gravimetric	0.01 mg/m^3
Metals (antimony, copper, lead, silver, and tin)	membrane filter	full shift	plasma emission	0.01 mg/m^3
PB-fusion and flux decomposition products				
semi-volatile	teflon filter	full shift	GC-MS[c]	various
volatile	tenax tube	full shift	GC-MS	various
formaldehyde	Orbo-24 tube	full shift	GC-NPD[d]	0.05 ppm

[a]value shown is detection limit for sample of typical volume; for full-shift samples, this is expressed as the indicated 8-hour TWA exposure, based on typical sampling times.

[b]gas chromatography with flame ionization detector.

[c]gas chromatography/mass spectrometry.

[d]gas chromatography with nitrogen-phosphorus detector.

APPENDIX B

Methods used to identify suitable monitoring sites.

Site Search Process

The overall strategy in searching for CPVC-pw installation sites was to establish contacts at all levels of the plastic-pipe distribution system, shown below:

Resin manufacturer
↓
Extruders
↓
Distributors
↓
Local suppliers
↓
Plumbing contractors
↓
Workers

To identify contractors using CPVC pipe, contacts were made with the U.S. manufacturer of CPVC resin, most CPVC pipe manufacturers, many regional distributors, and dozens of local suppliers. The resulting chain of referrals ultimately led to a small number of firms familiar with CPVC installation. The network of referrals is described below. Plumbing inspectors also proved to be a rich source of information about local plastic pipe installation practices. Several other sources were also consulted to generate new leads: telephone directories, trade associations, and local union business agents, whose names were provided by pipe trades unions. Tables A-1 and A-2 show a partial listing of the organizations contacted.

Only one contractor was identified (in Nevada County) who used CPVC-pw occasionally in custom homes. Where permitted, CPVC-pw was used primarily by do-it-yourselfers. A number of prefabricated-home and mobile-home distributors and manufacturers were contacted but they did no CPVC-pw installation in California.

When it became clear that the search for needed sites would have to extend beyond California, leads to CPVC-pw installations in Nevada, Oregon, Washington, and later Arizona were investigated. Using the above methods, no suitable CPVC-pw installation sites were located. A slightly less rigorous search technique was also used for Orlando, Florida, with no CPVC-pw sites located.

All contacts questioned about CPVC-pw were also asked about the use of PVC in California. PVC was generally permitted and frequently used for water service outside residences and for garden sprinkler systems, and was occasionally used for air-conditioner condensate lines inside homes. No PVC condensate installation sites were monitored, because contractors reported that this work was usually done in brief periods between other job tasks. No garden-sprinkler sites were monitored because the outdoor conditions were judged to be substantially different than indoor CPVC installation. According to these sources, PVC is rarely used for DWV in California.

Many referrals, no sites

The following paragraphs illustrate the numerous leads that were followed, and how these ultimately led to very few contractors installing CPVC-pw pipe.

Eight manufacturers supply most CPVC pipe used in North America. They are:

Company Name	Headquarters
Bow	Montreal, Canada
CGF	Ardmore, AL
Cresline	Evansville,IN
Genova	Davison, MI
Nibco	Elkhart, IN
R&G Sloane	Sun Valley, CA
Thompson	Huntsville, AL
U-Brand	Ashland, OH

Described below are the referrals provided by these manufacturers. These are provided to illustrate that various referrals ultimately led to a small number of appropriate suppliers and contractors for the purpose of this study.

Bow, CGF, Cresline, Genova, and Thompson do not service the West Coast or Nevada.

Nibco manufactures only industrial plastics and made referrals to various industries such as Chevron and Dow Chemical, etc. that use CPVC, but none of these companies used CPVC in a fashion comparable to pw distribution. Nibco also made a referral to Spears, manufacturer of Blazemaster glues, in Sylmar, California.

R&G Sloane made a referral to: 1) Western States Sales (Washington agent) who made a referral to Famillion N.W. and Perry (retailers in Oregon). Both Famillion and Perry sold only small quantities for do-it-yourselfers. Famillion made a referral to their Las Vegas branch who made a referral to a local contractor who did not use CPVC, and to Turf Supplies who made referrals to contractors who

weren't using CPVC; 2) New Horizon Sales (Arizona agent) made a referral to Buffington & Associates (services Northern California and Northern Nevada) who in turn made a referral to PE O'Hair in Pittsburg, California who made a referral to a contractor who used CPVC for hot tubs and Western Nevada Supply in Sparks, Nevada (no CPVC); 3) their product manager for sprinkler products made a referral to the American Fire Sprinkler Association and three fire sprinkler companies, all in Southern California.

U-Brand made a referral to 10 wholesalers in Arizona: no contractor referrals were received from them. Sales of CPVC were only made to do-it-yourselfers. One wholesaler made a referral to Nibco, another to Spears.

Spears, manufacturer of Blazemaster, had already been contacted by B.F.G. and made a referral to Grinnell Supply, a Southern California fire sprinkler contractor, PE O'Hair in San Francisco (who made a referral to their Pittsburg branch), and to Harrington Plastics who made a referral to A.M.K., a company already referred by Nibco. Harrington also made referrals to three retailers and two contractors, none of whom sold or used CPVC in residences. These contacts made referrals of their own which were equally fruitless.

U-Brand also made referrals to 27 wholesalers in California and one in Oregon. None of these was able to supply us with contacts of retailers or contractors involved with CPVC for pw.

Names of other plastic pipe manufacturers and suppliers were obtained via various organizations and associations. Following is an illustration of some of the referrals made from these groups.

J.M. manufacturers in California only produced PVC. Pacific Western in Oregon made a referral to three distributors: Ewing in California (no CPVC); United Plastics in Oregon who made a referral to Famillion in Oregon (sold to do-it yourselfers only); and H.D. Fowler in Washington who made a referral to Jim Flag who made a referral to AMFAC who made a referral back to H.D. Fowler who than made a referral to Keller Supply who didn't sell CPVC and made a referral to three Seattle plumbers who did not use it. Also contacted were Tyler Pipe Manufacturer and Bay Plastics, both of Texas, neither of whom currently manufacture CPVC.

Table B-1. Building departments, distributors, and suppliers contacted for assistance in locating suitable sampling sites.

City/County Bldg.& Plumbing Depts.:	
CA:	88
NV, OR, WA, AZ, FL, GA:	37
Mobile and Pre-Fab Home manufacturers & distributors:	16
Plumbing Distributors and Suppliers:	
CA:	45+
Other:	35+
Plumbing Contractors:	
CA:	75+
NV:	65+
GA:	30+
Other:	10
California Fire Marshalls:	11
Fire Sprinkler Contractors:	50+

Table B-2. Trade associations contacted for assistance in locating suitable sampling sites.

Associated Builders and Contractors (CA)
Associated General Contractors (CA)
Association of General Contractors of California
Association of Builders and Contractors (NV)
Association of General Contractors (NV)
Associated Plumbing & Mechanical Contractors of Sacramento, Inc. (CA)
AFSA-American Fire Sprinkler Association
ASA-American Supply Association
AIM/R-Association of Industrial Manufacturers Representatives
Association of Builders and Contractors (NV)
CBIA-California Building Industry Association
CALBO-California Building Officials
Coalition For Home Fire Sprinklers
Dallas Trade Association (TX)
Home Builders Association of Portland (OR)
Home Builders Association (NV)
ICBO-Industrial Conference of Building Officials
International Association of Fire Chiefs
IAPMO-International Association of Plumbing & Mechanical Officials
IRC-Industrial Relations Council for the Plumbing & Pipefitting Industry
Lobby Group Plumbing & Heating Contractors (OR)
Mechanical Contractors Association of California
Mechanical Contractors Association of America
NAPD-National Association of Plastics Distributors
National Association of Remodeling Industry (FL)
National Fire Sprinkler Association
NSPC-National Standard Plumbing Code Committee
National Sanitation Foundation
Oregon State Home Builders Association (OR)
Oregon Home Builders Association (OR)
Plastic Pipe Technical Center (OH)
PPFA-Plastic Pipe Fitters Association
PHCC-Plumbing, Heating & Cooling Contractors of California
Plumbing & Mechanical Suppliers of Washington (WA)
PDI-Plumbing & Drainage Institute
PMI-Plumbing Manufacturers Institute
PPIC-Plastic Pipe Industry Council
Southern Nevada Plumbing Association (NV)
Unibell Pipe Association (TX)

APPENDIX C

Exposure limits used for evaluation of worker exposures.

Substance	Exposure Limit 8-Hour TWA	15-Minute	Source 8-Hour	15-Minute
MEK	200 ppm	300 ppm	N,A,O	A,O
THF	200 ppm	250 ppm	A,O	A,O
CHX	25 ppm	75 ppm	N,A,O	A[a]
ACE	250 ppm	1000 ppm	N	A,O
DMF	10 ppm[b]	none	A,O	--
antimony	0.5 mg/m^3[b]	none	N,A,O	--
copper	0.2 mg/m^3	none	A	--
lead	0.05 mg/m^3	none	O	--
silver	0.01 mg/m^3	none	O	--
tin	2 mg/m^3	none	A,O	--
formaldehyde	1 ppm	2 ppm	O	O

[a]According to ACGIH guidelines, this value should be exceeded (as a 15-min average) no more than twice per day.

[b]Does not address potential carcinogenicity.

Sources:

N = NIOSH Recommended Exposure Limits, as listed in Morbidity and Mortality Weekly Report 1986;35(1s):1s-33s.

A = American Conference of Governmental Industrial Hygienists. Threshold Limit Values and Biological Exposure Indices for 1987-1988.

O = US OSHA Regulations; 29 CFR 1910.

Tetrahydrofuran

CAS# 109-99-9 ACGIH TLV-TWA: 200 ppm OSHA PEL: 200 ppm

TLV-STEL: 250 ppm OSHA STEL: 250 ppm

HUMAN TOXICOLOGY: Tetrahydrofuran is capable of irritating the eyes and upper respiratory tract. It is also a CNS depressant. Symptoms of overexposure in workers include headache, dizziness and nausea. These symptoms are readily reversible. It is also a defatting agent and prolonged skin contact may cause dermatitis.There are few reports of chronic toxicity in the literature. There is a case report of IgA glomerulonephritis developing in a worker exposed to high levels of THF (389-757 ppm) while working in a confined area. The odor threshold is 25 ppm.

ANIMAL TOXICOLOGY: THF is an irritant of the eyes and upper respiratory tract in test animals. It is also a CNS depressant at high air levels. No chronic toxicity studies (reproductive, carcinogenicity, neurotoxicity) have been reported.

Dose Response of Adverse Effects of THF on Test Animals.

400 ppm	12 weeks	No histopathological effects (dogs)
2000 ppm	18 weeks	Decreased hepatic alcohol and formaldehyde dehydrogenase activity (rats).
3,000 ppm	20 days	Upper respiratory tract irritation Technical grade may cause liver and kidney damage from peroxide contamination.
17,000 ppm	30 days	No liver or kidney injury (rabbits, cats)
25,000 ppm		Anesthesia (dogs, mice)
20% solution on skin		Inconsistent reports of irritation.

TLV DOCUMENTATION: The existing toxicity information for THF is extremely limited. In particular,the health effects of ongoing exposure cannot be fully assessed, because no chronic toxicity studies have been reported. However, the few germane reports available were addressed in setting the TLV and PEL for this substance. No published information would warrant setting a different exposure limit for this investigation.

Methyl ethyl ketone

2-Butanone
CAS# 78-93-3

ACGIH TLV-TWA: 200 ppm OSHA PEL: 200 ppm

ACGIH TLV-STEL: 300 ppm OSHA STEL: 300 ppm

HUMAN TOXICOLOGY: MEK vapors are irritating to the eyes and upper respiratory tract. It is also a CNS depressant. Methyl ethyl ketone also potentiates the neurotoxicity of n-hexane and methyl butyl ketone. Combined workplace exposure to both MEK and n-hexane has caused outbreaks of peripheral neuropathy in a number of workplaces. There have been a few case reports of chronic MEK exposure, in combination with chronic exposure to other solvents such as THF or toluene, causing peripheral neuropathy. In one such report, the levels of MEK involved were below the TLV.

Effect of Air Concentrations on MEK's Acute Toxicity:

5-10 ppm	Odor threshold (100% response)
100 ppm	Slight nose and throat irritation
200 ppm	Mild eye irritation Estimated satisfactory concentration 50% response for eye and nose irritation.
350 ppm	Objectionable concentration
300-500 ppm	Headache, irritation, nausea
300-600 ppm	Numbness of the fingers and arms reported in one incident.
3300 ppm	Moderately irritation to eyes and throat. (momentary exposure).
33,000 ppm	Intolerable irritation of the eyes, nose, and throat (momentary exposure).

MEK is a defatting agent and may cause dermatitis upon prolonged skin contact. The liquid is absorbed through the skin.

ANIMAL TOXICOLOGY: The LC(50) for 4 hours exposure is 12,000 ppm for the rat. 6000 ppm caused fatal delayed bronchopneumonia in 100% of treated rats at seven weeks. In teratogenicity tests conducted in the rat, 3,000 ppm caused slight fetotoxicity (but no signs of embryotoxic or teratogenic effects); 1000 ppm and lower doses were without effect. In several studies, subchronic exposures up to 2500 ppm have been found to produce only slight effects on test animals (slight increase in SGPT at 2500 ppm in one study). MEK potentiates the neurotoxicity (peripheral nerve injury) of n-hexane in animal tests. An MEK air level of 200 ppm potentiated this effect of n-hexane in one rat study. The ability of lower levels of MEK to potentiate n-hexane's neurotoxicity has not been tested. In a number of animal studies, high doses of MEK (up to 6000 ppm) alone did not cause peripheral neuropathy. MEK has been reported to potentiate the hepatotoxicity of chloroform in the rat as well. No cancer bioassays have been conducted using MEK.

TLV DOCUMENTATION: The TLV documentation did not address animal studies describing the slight fetotoxicity of MEK at very high doses, the ability of MEK to potentiate the neurotoxicity of n-hexane and methyl butyl ketone in both test animals and overexposed workers, or the ability of MEK to increase the hepatotoxicity of chloroform in test animals. It is not known whether or not MEK at levels near or below the TLV would potentiate the toxicities of these agents in workers; for this reason, combined exposures to these agents should be avoided. The TLV documentation does not address the case reports which describe neuropathies developing in instances of combined exposure to MEK and other solvents (acetone, THF, toluene). In every instance, except one in which the combined exposures included acetone and toluene, these reports involved situations of likely gross overexposure. Excepting these case reports, the literature and use experience strongly indicate that exposure to MEK does not cause peripheral neuropathies.

It is uncertain as to whether or not the current TLV protects against MEK potentiation of the neurotoxicity of other solvents. The present TLV is adequate as an evaluation criteria for MEK exposure in the absence of combined exposures to n-hexane or methyl butyl ketone. With respect to combined exposure to THF and MEK, there is very little information on which to judge the existence or magnitude of hazard. In the one report involving THF and MEK, excessive skin and inhalation exposure (the worker used bare hands to handle THF adhesive-based, used MEK as a solvent and to clean hands; and used both solvents in a trench) was likely. No other reports of an interaction between THF and MEK exist. In the absence of confirmation of this effect, of reliable dose-response information, and of consistent animal toxicity findings, there is no basis for setting an evaluation criteria for this investigation which would be different from the current TLV-TWA for MEK.

Cyclohexanone

CAS# 108-94-1 ACGIH TLV-TWA: 25 ppm, S OSHA PEL: 25 ppm

NIOSH Recommended PEL: 25 ppm

HUMAN TOXICOLOGY: Vapors irritate the eyes, throat and upper respiratory tract. In one study, a majority of exposed subjects found 75 ppm to cause objectionable irritation of the eyes, nose, and throat; 50 ppm was found to cause some throat irritation; and 25 ppm was judged to be an acceptable working atmosphere by the majority of subjects. Cyclohexanone is a defatting agent causing dermatitis upon prolonged contact.

ANIMAL TOXICOLOGY: Cyclohexanone is a central nervous system depressant at high doses. The liquid caused moderate irritation and some corneal injury when placed in the eye of a rabbit. Chronic subcutaneous or cutaneous administration of cyclohexanone caused cataracts in guinea pigs. Subchronic exposure of rabbits and monkeys to 190 ppm caused slight kidney and liver injury. There are negative NTP drinking water bioassays on cyclohexanone conducted in both sexes of rats and mice. At very high doses of about 1 g/kg/day no significant histopathology was found in the subchronic phase of these NTP bioassays. In a reproductive toxicity study, exposure to 1,000 ppm for one generation and exposure to 250 ppm or 500 ppm for two generations were without adverse effects on reproductive performance or outcome, including behavioral neurotoxicologic endpoints. Continued exposure of the high-dose second generation to 1,400 ppm resulted in adverse effects such as lethargy, body weight depressions, reduced male fertility, reduced progeny survival, and reduced progeny body weight.

TLV DOCUMENTATION: The major reports covering irritation, hepatotoxicity, acute lethality, and renal toxicity in test animals, and reports of acute irritation in humans were addressed in setting the TLV for this compound. The documentation is sufficiently comprehensive to justify the use of the TLV-TWA as the evaluation criteria in this investigation.

Acetone

(CAS# 67-64-1)

ACGIH TLV-TWA: 750 ppm OSHA PEL: 750 ppm

ACGIH TLV-STEL: 1000 ppm OSHA STEL: 1000 ppm

NIOSH REL: 250 ppm

HUMAN TOXICOLOGY: Vapors irritate the eyes, throat, and upper respiratory tract. Acetone may cause this irritation at air levels below current TLV-TWA and PEL values (see table 1). Tolerance to this irritation may develop with continued exposure. At very high air levels, acetone is a CNS depressant. Complaints of CNS depression (light-headedness, weakness, dizziness, and headache) have occurred in workers grossly overexposed to acetone vapors. One controlled study examined the effect of airborne exposure to 250 ppm of acetone on performance in six neurobehavioral tests. This study found slight, but statistically significant, performance decrements on several measures (two measures of auditory tone discrimination, and on the anger hostility scale of a Profile on Mood States tests for the male subjects only) out of the many neurobehavioral parameters assessed. These results suggest that acetone exposures of 250 ppm can cause a mild CNS depression.

Acetone is well absorbed by inhalation and ingestion. About one-half of an inhaled dose is absorbed. The major route of excretion is via expired air. Acetone is a defatting agent causing dermatitis upon prolonged contact with the skin. Acetone is a product of human metabolism and is also a metabolite of isopropanol.

ANIMAL TOXICOLOGY: Acetone causes narcosis and irritation in test animals. In a number of studies, acetone has been found to potentiate the toxicity of other solvents including halogenated hydrocarbons. In one such study, acetone at the lowest tested dose (40 mg/kg, roughly equivalent to 250 ppm) potentiated the hepatotoxicity of compounds such as carbon tetrachloride and trichloroethylene in the rat. Acetone also potentiates the toxic effects of chloroform on the liver and kidney. Acetone has also been found to potentiate the toxicity of acrylonitrile by altering the rate at which it is metabolized to cyanide. It may also potentiate the neurotoxicity of n-hexane and methyl n-butyl ketone by altering the toxicokinetics of the 2,4-hexanedione metabolite of these compounds.

No studies of the reproductive toxicity or carcinogenicity of acetone were available.

Human Health Effects Resulting from Exposures to Acetone Below or Near Exposure Guidelines.

Acetone Level	Effect	Study
250 ppm	slight neurobehavioral effects	Dick, *et al.*
300 ppm	slight irritation	Nelson, *et al.*
500 ppm	tolerable irritation	" "
100 ppm	transient irritation	Matsushita, *et al.*
250 ppm	transient irritation	" "
500 ppm	transient irritation	" "
1000 ppm	transient irritation	" "
300-900 ppm	eye, throat irritation in exposed workers	Parmeggianni, *et al*
700 ppm	irritation of the respiratory tract, giddiness	Vigliani, *et al.*
100 - 500 ppm	no irritation	Divencenzo, *et al.*

TLV DOCUMENTATION: Four studies have reported acetone to cause mild irritation of the eyes or mucous membranes at air levels below or near the PEL and TLV values for this compound. One study failed to find an effect at exposures below the current TLV. Short-term irritation is a material impairment to health. The several studies finding irritation at levels below the TLV require the use of the NIOSH REL as the evaluation criteria in this investigation. Use of the NIOSH REL will also help protect against any adverse interactions in the event of exposure to mixtures of solvents.

Dimethylformamide

CAS# 68-12-2 ACGIH TLV-TWA: 10 ppm, S OSHA PEL: 10 ppm, S

HUMAN TOXICOLOGY: Hepatotoxicity (hepatomegaly, altered liver function tests, jaundice) has been observed in overexposed workers. In one workplace, a high proportion of heavily overexposed workers were found to have been affected. Well absorbed dermally; skin absorption is usually a factor in systemic toxicity. May cause an ANTABUSE-like reaction with alcohol at levels near the PEL. A defatting agent causing dermatitis. Symptoms of overexposure include nausea, vomiting, abdominal pain, dizziness, and facial flushing. Epidemiological investigations have suggested an association of DMF with an increased incidence of testicular cancer in heavily exposed men. However, the lack of exposure measurements prevents quantitatively assessing the possible cancer risk to workers exposed at the PEL. In addition, the association with DMF may not be specific as the possibility that cadmium exposures occurred in the three studied workplaces has been raised.

ANIMAL TOXICOLOGY: To date, animal studies are inadequate to reliably assess the carcinogenic potential of DMF. The National Toxicology Program is preparing to test DMF under its cancer bioassay protocols. Those results may not be available for several years. Monomethylformamide, a major metabolite of DMF, is highly teratogenic in rodents. However, a review of the majority of studies with DMF suggested that it is not teratogenic, but may be embryolethal at high doses. Levels of DMF at or above 100 ppm have been found to cause liver and kidney injury in rats.

TLV DOCUMENTATION: The major reports covering hepatotoxicity, acute lethality, renal toxicity, carcinogenicity, and reproductive effects in test animals, and reports of acute illness and liver injury in humans were addressed in setting the TLV for this compound. The documentation is sufficiently comprehensive to justify the use of the TLV-TWA as the evaluation criteria in this investigation.

Toxicity References

General

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APPENDIX D

Characteristics of sites monitored.

Table D-1. Counties and states in which monitoring sites were located, and the number of sites and site days per area.[a]

County/State	Sites monitored	Site-days of monitoring
Georgia[b]	7	15
Alameda	4	4
San Bernadino	2	4
Santa Clara	2	4
Contra Costa	2	3
Riverside	2	3
Solano	2	3
Los Angeles	2	2
Sacramento	2	2
Napa	1	1
Shasta	1	1
Sonoma	1	1
Totals	28	43

[a]The site selection search was initially focused on the California counties with the most new construction: Los Angeles, San Diego, San Bernadino, Orange, Riverside, Contra Costa, Sacramento, Alameda, Santa Clara, and Ventura. No suitable sites were identified in Orange, San Diego, or Ventura counties.

[b]all CPVC-pw and DWV-PVC sampling was done in Georgia.

Table D-2. Selected characteristics of each site.

Site	Workers	Installation	Referral Sources[a]
1	2	copper	Union
2	3	copper	Bldg. Dept
3	1	DWV-ABS	Union
4	1	copper	Union
5	2	DWV-ABS	Union
6	3	CPVC-fire	Fire Marshall
7	1	DWV-ABS	Union
8A	4	CPVC-fire	Fire Marshall
8B	4	CPVC-fire	Fire Marshall
9	2	CPVC-fire	Fire Marshall
10	1	copper fire	Fire Marshall
11	4	CPVC-fire	Fire Marshall
12	1	CPVC-fire	Fire Marshall
13A	2	CPVC-fire	Fire Marshall
13B	2	CPVC-fire	Fire Marshall
14A	3	CPVC-fire	Fire Marshall
14B	3	CPVC-fire	Fire Marshall
14C	2	CPVC-fire	Fire Marshall
15	3	DWV-PVC	Resin Manufacturer
16A	2	CPVC-pw	Resin Manufacturer
16B	2	CPVC-pw	Resin Manufacturer
17A	3	CPVC-pw[b]	Resin Manufacturer
17B	3	CPVC-pw[b]	Resin Manufacturer
18A	4	DWV-PVC	Resin Manufacturer
18B	2	DWV-PVC	Resin Manufacturer
19	3	CPVC-pw	Resin Manufacturer
20	1	DWV-PVC	Resin Manufacturer
21	1	CPVC-pw[b]	Resin Manufacturer
22A	3	DWV-PVC	Resin Manufacturer
22B	3	DWV-PVC	Resin Manufacturer
23	2	CPVC-pw[b]	Resin Manufacturer
24	2	DWV-PVC	Resin Manufacturer
25	2	CPVC-pw	Resin Manufacturer
26	2	copper	Union
27	2	DWV-ABS	Union
28	1	copper	Union
29	2	CPVC-fire	Union
30	2	copper	Union
31	2	CPVC-fire	Union
32	2	copper	Union
33	1	copper	Union
34	1	PB fusion (snow melt)	Manufacturer
35	3	DWV-ABS	Union

[a] Contractors were sometimes referred from more than one source. Only the more direct or timely source is given.

[b] also had DWV-PVC

APPENDIX E

Contents of bulk primer and cement samples.

Product	Use	Ingredients listed on label	%THF	%MEK	%CHX	%ACE	%DMF
	CPVC-pw Products						
20	primer	MEK,ACE,THF	28.0%	12.0%	0.7%	55.0%	0.0%
24	primer	MEK,THF,CHX,DMF	(45.0)[a]	(37.5)	(10.0)	(0.0)	(7.5)
28	primer	THF	(80.0)	(0.0)	(0.0)	(0.0)	(0.0)
5	cleaner	MEK,ACE	0.0	6.9	0.0	77.7	0.0
1	cement	THF,MEK.CHX	65.9	10.5	7.3	0.0	0.0
2	cement	THF,MEK.CHX	68.4	14.1	6.7	0.0	0.0
7	cement	THF,CHX	85.4	0.0	10.6	0.0	0.0
8	cement	THF,CHX	77.7	0.0	12.3	0.0	0.0
	CPVC-fire Products						
11	primer	THF	79.0	1.0	0.0	0.0	0.0
14	primer	DMF,MEK,CHX,THF	29.5	25.0	7.7	0.0	0.0
12	cement	THF,MEK,CHX	67.9	14.6	5.6	0.0	0.0
15	cement	MEK,CHX,THF	60.4	12.2	11.6	0.0	0.0
	DWV-PVC Products						
3	cement	THF,DMF	59.4	0.1	0.1	0.0	30.5
4	cement	MEK,THF,CHX	7.2	6.2	0.8	0.0	0.0
6	cement	THF,CHX	77.7	0.2	13.4	0.0	0.0
9	cement	THF,CHX	26.0	0.5	18.6	0.0	0.0
27	cement	THF,MEK,CHX	(40.0)	(37.5)	(7.5)	(0.0)	(0.0)
	DWV-ABS Products						
10	cement	MEK	0.8	62.7	0.1	0.0	0.0
16	cement	MEK	0.0	68.2	0.2	0.0	0.0
19	cement	MEK	(0.0)	(75.0)	(0.0)	(0.0)	(0.0)

[a]values in parentheses were supplied by manufacturers; no bulk samples of these products were analyzed.

APPENDIX F

Alloy composition of copper solders collected at 4 work sites. All values are percentages of bulk material.

Sample No	Silver(%)	Copper(%)	Antimony(%)	Tin(%)	Lead(%)
315	0.7	4.3	0.2	91.7	0.12
530	0.3	0.2	0.2	94.3	0.19
553	1.0	4.7	0.2	85.6	0.22
136	0.3	2.5	2.6	61.0	0.26

APPENDIX G

Results of laboratory quality assurance program.

Figure G-1. Concentrations measured in paired air samples collected on charcoal and ambersorb sorbent tubes: a) THF, and b) MEK. Concentrations are in ppm.

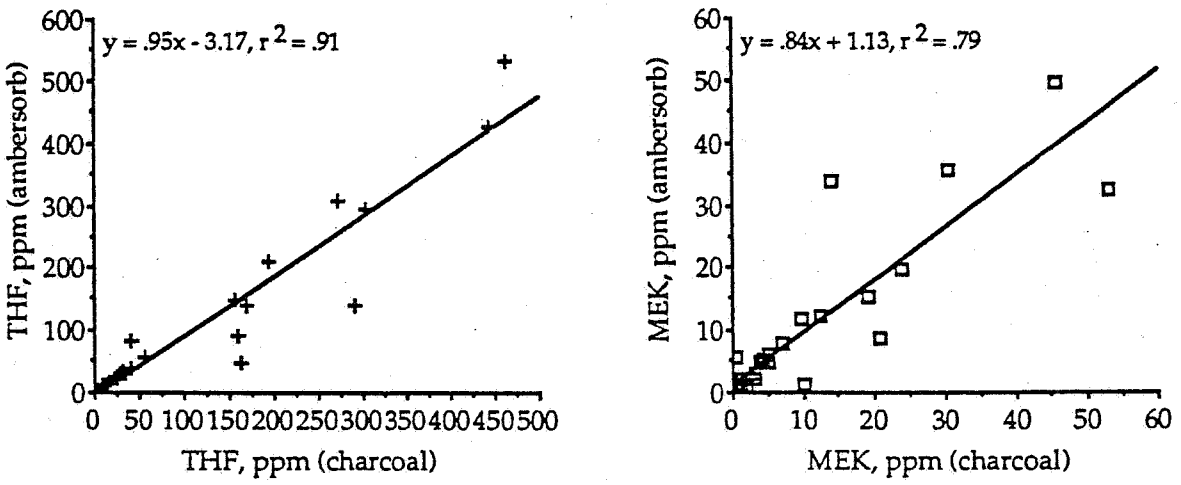


Figure G-2. Laboratory quality assurance: quantities of THF that were spiked and later determined (blind) for 12 charcoal and 4 ambersorb tubes.

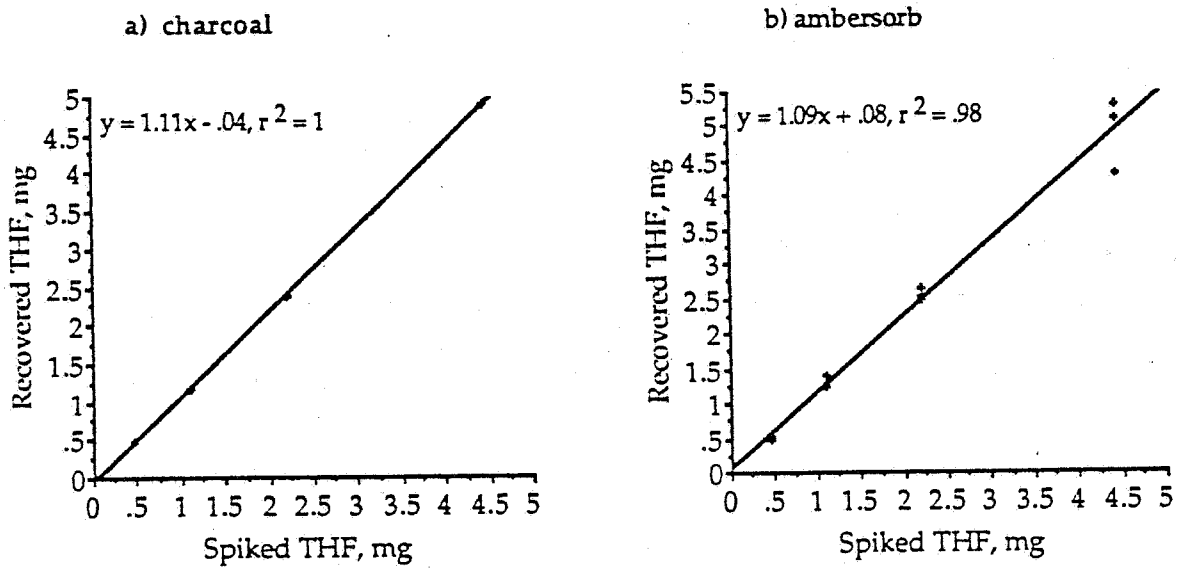


Figure G-3. Laboratory quality assurance: quantities of MEK that were spiked and later determined (blind) for 12 charcoal and 4 ambersorb tubes.

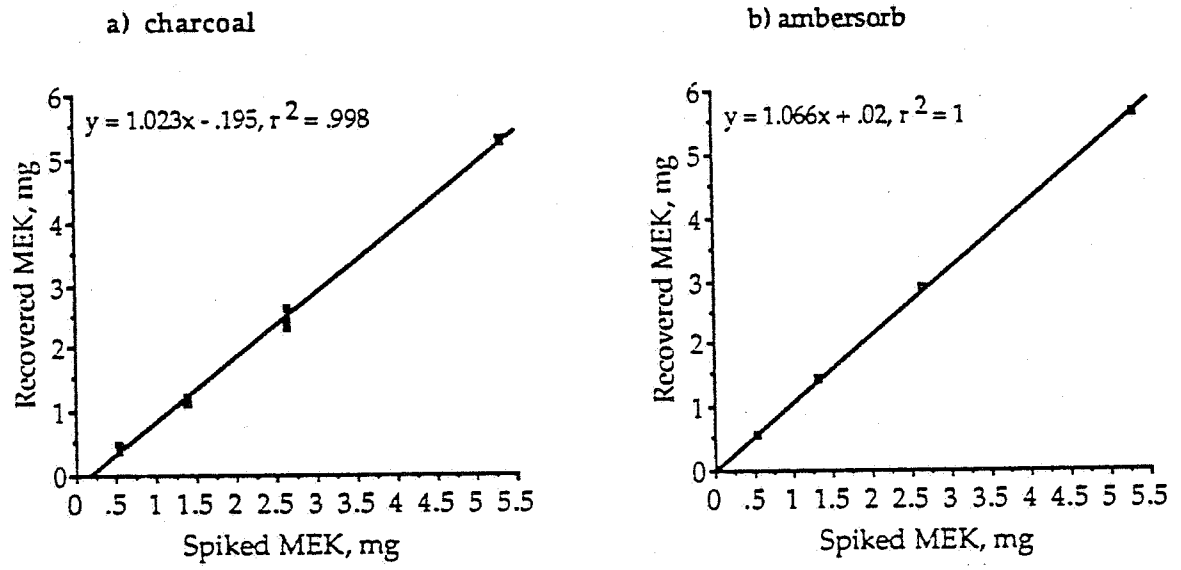


Figure G-4. Laboratory quality assurance: quantities of CHX that were spiked and later determined (blind) for 12 charcoal and 4 ambersorb tubes.

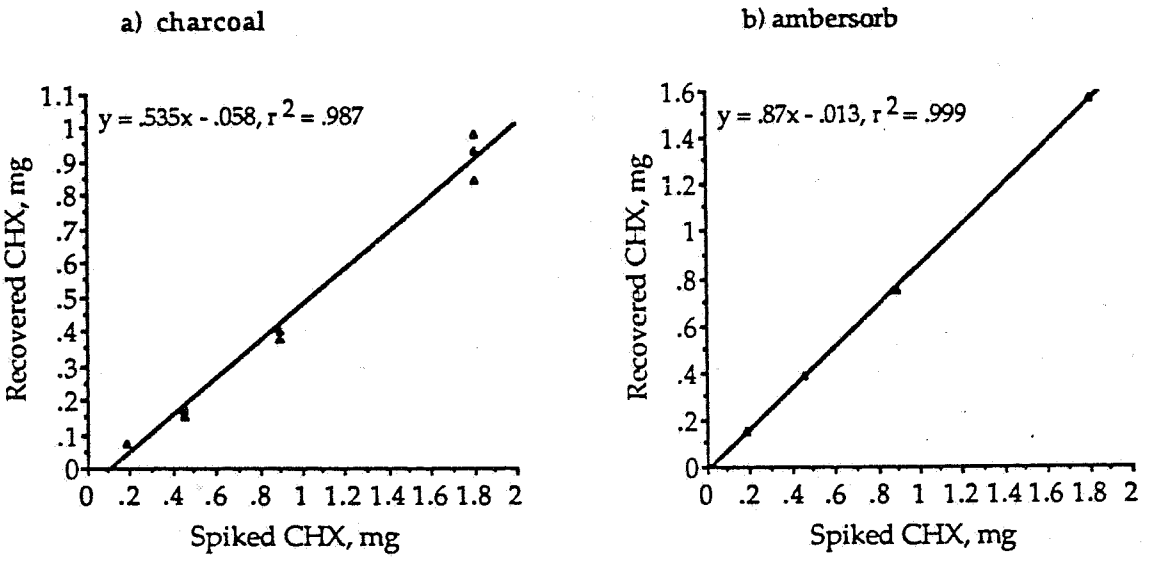
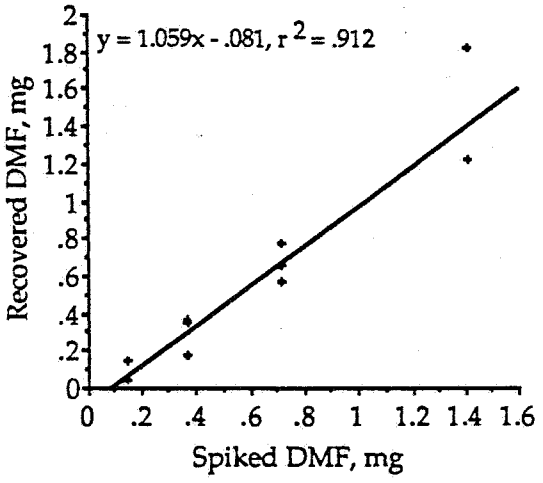


Figure G-5. Laboratory quality assurance: quantities of DMF that were spiked and later determined (blind) for 12 silica gel tubes.



7

MEMORANDUM

SUBJECT: Plastic Pipe for Domestic Water Supply
: Implications of Pipe Use Simulation for Long-term Exposure.
:

TRA JOB: LPPC
DATE: 2/15/88
FROM: Tom Reid

TO: Tom Adams, Dan Cardozo
Adams, Broadwell and Russell
1875 South Grant Street, Suite 600
San Mateo, CA 94402-2662

The Plastic Pipe Leaching Study conducted by SEHRL with Acurex laboratory showed persistent, high levels of solvents in the CPVC pipe systems. The results were the first available to show the likely rate of leaching over a moderate-term usage scenario. While it turns out that there was still significant leaching when the study was terminated (THF and MEK levels above 100 ppb) the longterm leaching can be reasonably inferred from the data.

Implications of Pipe Use Simulation for Long-term Exposure.

Four major solvents were found at high levels: tetrahydrofuran (THF), methylethylketone (MEK), cyclohexanone, and acetone. Initial levels of thousands of ppb declined during the preoccupancy phase. Going into the occupancy phase, THF and MEK were typically above 1000 ppb and declined slowly, falling a to a tenth of the initial value over the 60 day occupancy phase.

While the initial high levels are not unexpected, given the sheer quantity of solvent cement used to join the pipes, the persistence of the solvents was greater than suggested by previous shorter-term studies. Indeed, one of the motivations for the test protocol was to remedy the obvious deficiency of data on long-term leaching.

The four pipe cells behaved in a similar fashion, even though the pipe joint compound was different. All cells followed the same sharp initial decline during pre-occupancy (days 1 to 14) and the gradual decline during occupancy (days 16 to 75). A typical example is offered by Pipe Unit C, where MEK levels followed the curve shown in Figure 1.

Since the logical source of the solvent is the mass of cement in the joint, a simple leaching model would have solvent leaching undergo an exponential decay with the rate of leaching proportional to the amount of solvent still remaining in the joint. Such exponential decay, or first order kinetics, has the general form:

$$A_t = A_o e^{-kt}$$

where A_t is the concentration of substance at time t,
A_o is the initial concentration at time zero, start of leaching,
e is the base of the natural logarithms
-k is the rate constant for decay, reflecting the diffusion rate

Logarithms of concentrations following first order kinetics will follow a straight line plot -- or may be graphed as a straight line on semi-log paper, as in Figure 2. Even on semi-log paper, there is an obvious curve to the plot, and this curve is exhibited for all solvents by all test units. When the sample data are fit to a line (see Figure 3), the curve is apparent, although the line is a good fit for the full 23 data points (r = -0.9579).

The shape of the curve is better illustrated when the semi-log plot is fit at three different periods: day 1 to 14 (5 samples), day 16 to 36 (9 samples), and day 39 to 75 (9 samples). Figure 4 shows the effect of estimating leaching behavior over the three separate periods. While the graph in Figure 4 shows only MEK from Unit C, all test data show the same phenomena. Table 1 lists the exponential curve fit for all compounds:

LnA_0 is the natural log of the initial, day zero concentration,
k is the exponential decay constant,
r is the correlation coefficient (-1.00 is perfect fit)
$LnA_0/-k$ is the time in days for the concentration to fall to 1 ppb.

In all cases, the value for k is less in the last study period than in the first study period -- often the k value is one quarter or one third, meaning that the leaching rate constant has declined abruptly. With a lower leaching rate constant, the solvent levels persist for a longer period of time. Thus the initial leaching rate of Unit C, MEK is -0.1225 which would have brought the leachate level to 1 ppb in 70 days, whereas between days 39 and 75 the leaching rate constant for the same cell fell to -0.0346 (28% of the earlier value) which projects levels above 1 ppb for 207 days.

The curve suggests deviation from pure first order leaching. The better description may be a higher order model, where the rate of leaching is proportional to the concentration of substance remaining raised to a power. There may be a plausible basis for such a phenomenon, such as the presence of the solvent altering the mechanical properties of the joint so that the diffusion rate through the joint is higher with higher solvent concentrations -- as the solvent dries up, the joint hardens and the remaining solvent is leached out more slowly.

An alternative model is to consider the solvent as leaching from multiple sources, each with a separate solvent content and with different intrinsic diffusion rates. The result would be two or more exponential leaching sources which would sum to show higher order leaching phenomena. Figure 5 illustrates the simple case of two sources for the MEK, Unit C example. In Figure 5, two separate sources are plotted: MEK-f for the "fast" leaching source, and MEK-s for the "slow leaching source. It is obvious that the fast source contributes most to the total MEK level during the first 10 days, whereas the slow source continues to put MEK into the water long after the fast source is essentially depleted.

The total MEK value is a curve, labeled SUM, which fits the data well: the values for the fast and slow source leaching were derived by difference from the exponential curve fit for the period 1 and period 3 data. With a lower effective leaching rate constant, the slow source projects levels of MEK above 10 ppb at day 120 and above 1 ppb for nearly a year. A more complex

model, particularly one based on leaching studies longer than 75 days, would show a more pronounced decline in leaching rate and significantly more persistent levels of solvent.

The present Pipe Leaching Study data do not support such extrapolation, but in the absence of a longer series test, it must be assumed that solvent levels above 1 ppb for MEK and THF would be found for at least a year after the pipe was installed.

The persistent solvent levels will contribute a fairly reactive source of organic material for formation of chlorinated organic compounds by reaction with chlorine residual in the water supply. When the several solvents are considered as total volatile organic, the prospect for significant exposure is clear.

|TSR

Figure 1. LINEAR PLOT OF MEK CONCENTRATION (UNIT C)

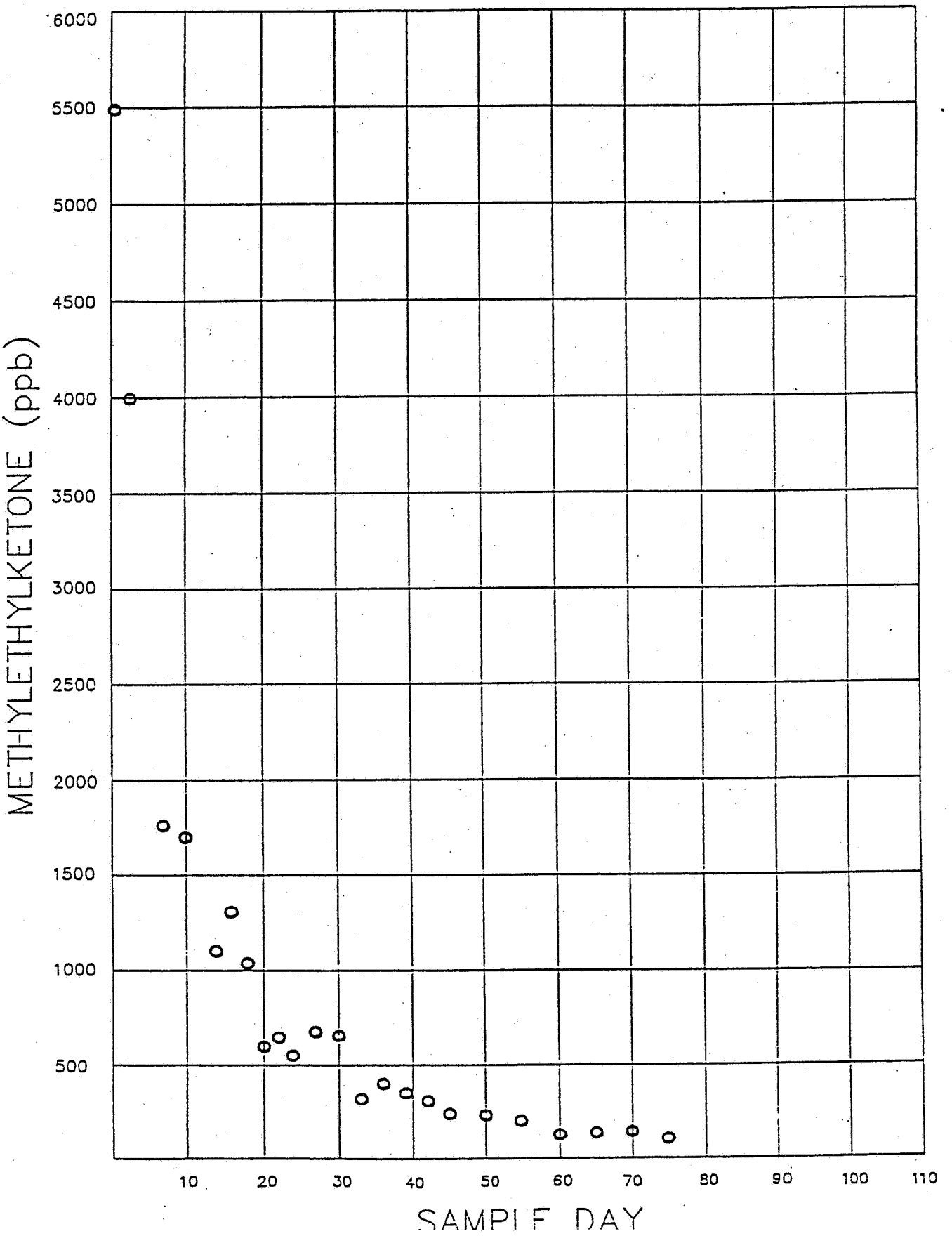


Figure 2. SEMILOG PLOT OF MEK CONCENTRATION (UNIT C)

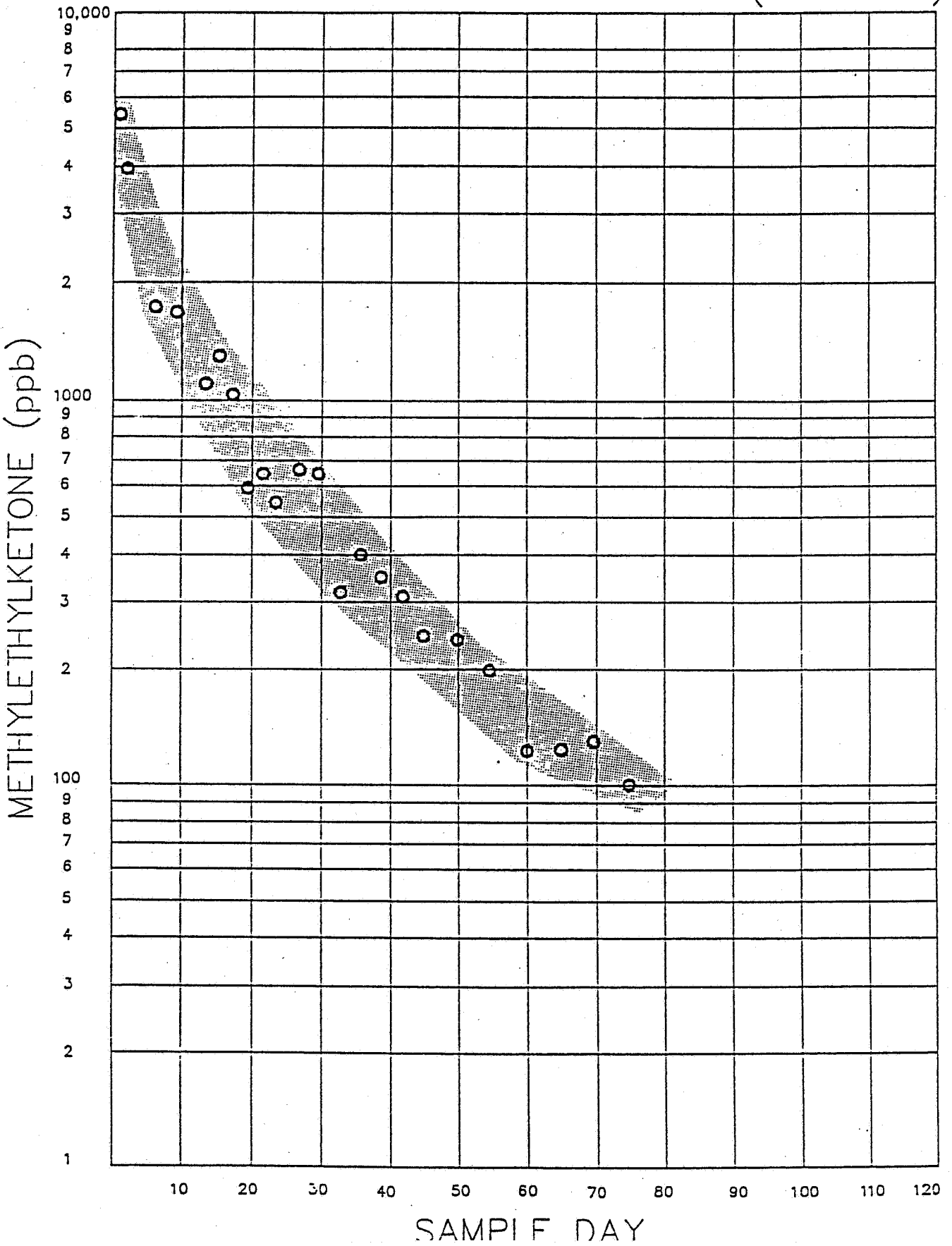


Figure 3. EXPONENTIAL CURVE FIT OF ALL SAMPLES

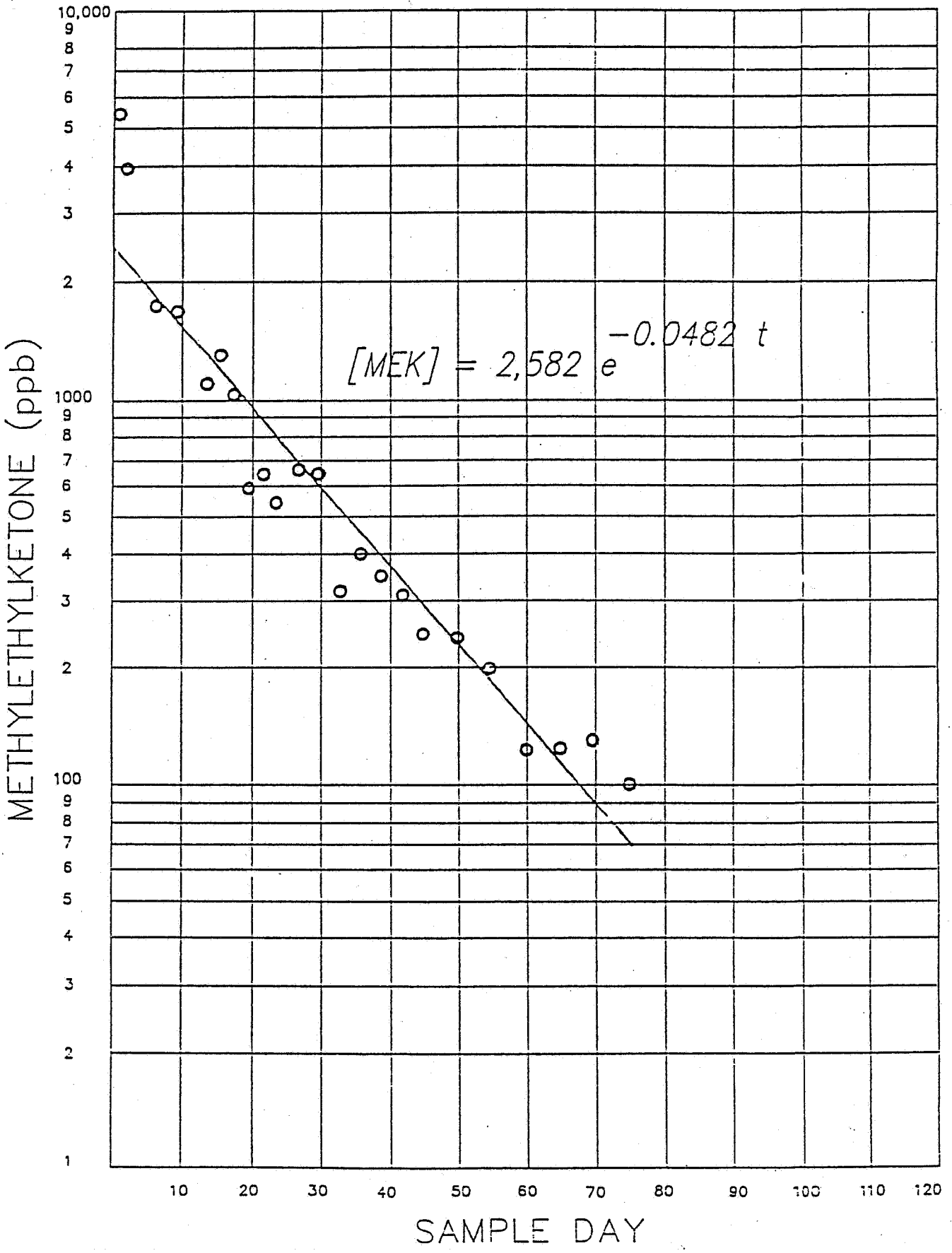


Figure 4. EXPONENTIAL CURVE FIT OF THREE SAMPLE GROUPS

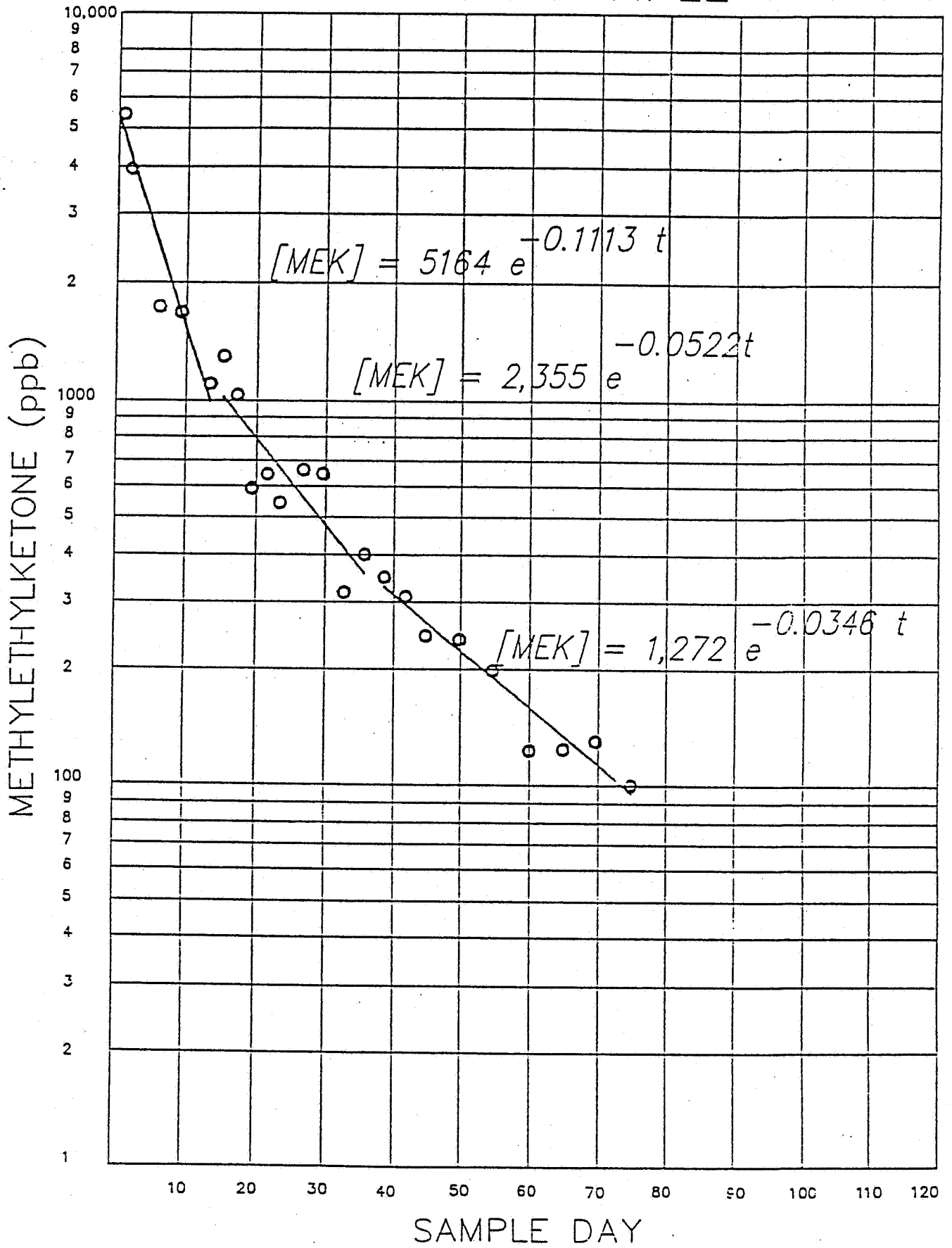


Figure 5. TWO SOURCE MODEL

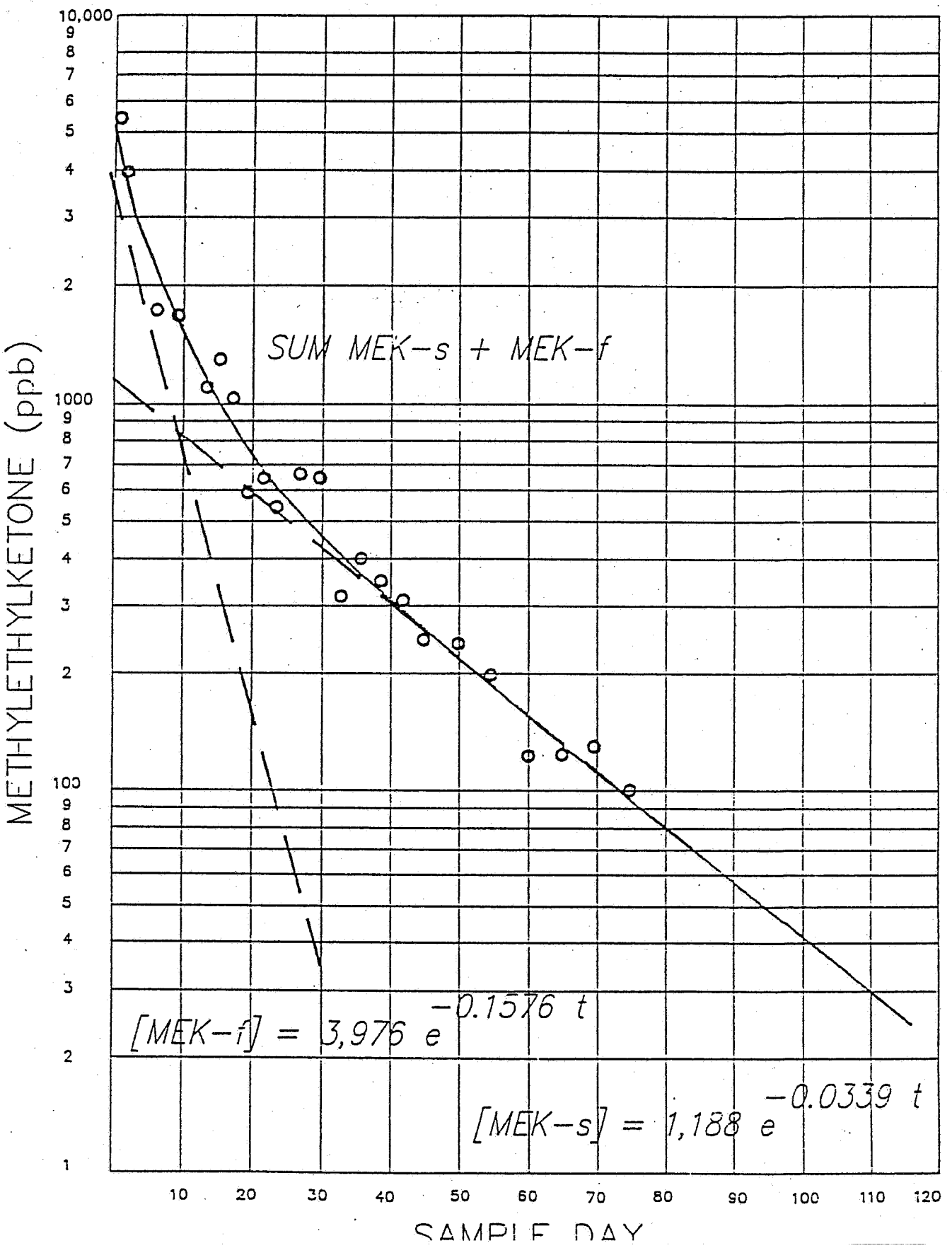


Table 1: Solvent Leaching Rates

TETRAHYDROFURAN

SAMPLING PERIOD	k	$\ln A_o$	r	$\ln A_o/-k$
UNIT A				
Period 1	-0.1762	8.5165	-0.8741	48.3343
Period 2	-0.0662	7.5931	-0.7306	114.6994
Period 3	-0.0320	6.7894	-0.8490	212.1688
UNIT B				
Period 1	-0.1348	8.7767	-0.9152	65.1091
Period 2	-0.0673	7.8943	-0.8011	117.3001
Period 3	-0.0334	7.2314	-0.9483	216.5090
UNIT C				
Period 1	-0.1612	8.4928	-0.9223	52.6849
Period 2	-0.0502	7.2958	-0.8432	145.3347
Period 3	-0.0218	6.4267	-0.8298	294.8028
UNIT D				
Period 1	-0.1471	8.4108	-0.8656	57.1774
Period 2	-0.0668	7.6977	-0.7274	115.2350
Period 3	-0.0264	6.5326	-0.8402	247.4470

METHYLETHYLKETONE

SAMPLING PERIOD	k	$\ln A_0$	r	$\ln A_0/-k$
UNIT A				
Period 1	-0.1136	8.2337	-0.9646	72.4798
Period 2	-0.0565	7.4569	-0.8769	131.9805
Period 3	-0.0236	6.0303	-0.6933	255.5212
UNIT B				
Period 1	-0.1113	8.5495	-0.9483	76.8149
Period 2	-0.0603	7.9311	-0.8893	131.5274
Period 3	-0.0420	7.5616	-0.9709	180.0381
UNIT C				
Period 1	-0.1225	8.6235	-0.9685	70.3959
Period 2	-0.0522	7.7644	-0.8408	148.7433
Period 3	-0.0346	7.1483	-0.9637	206.5983
UNIT D				
Period 1	-0.0691	8.1132	-0.9450	117.4124
Period 2	-0.0502	7.6626	-0.8961	152.6414
Period 3	-0.0350	7.0410	-0.9344	201.1714

CYCLOHEXANONE

SAMPLING PERIOD	k	$\ln A_0$	r	$\ln A_0/-k$
UNIT A				
Period 1	-0.2033	7.6316	-0.8316	37.5386
Period 2	--	--	--	--
Period 3	--	--	--	--
UNIT B				
Period 1	-0.2051	8.4660	-0.9015	41.2774
Period 2	-0.0739	6.4382	-0.6239	87.1204
Period 3	--	--	--	--
UNIT C				
Period 1	-0.2656	8.8106	-0.9187	33.1724
Period 2	-0.0688	6.2116	-0.5190	90.2849
Period 3	--	--	--	--
UNIT D				
Period 1	-0.1985	7.7077	-0.7760	38.8297
Period 2	-0.1105	7.2707	-0.9749	65.7982
Period 3	--	--	--	--

ACETONE

SAMPLING PERIOD	k	$\ln A_0$	r	$\ln A_0/-k$
UNIT A				
Period 1	-0.1751	6.1150	-0.7354	34.9229
Period 2	-0.0234	3.2478	-0.4851	138.7949
Period 3	--	--	--	--
UNIT B				
Period 1	-0.2787	6.6203	-0.9528	23.7542
Period 2	-0.0263	3.2567	-0.4597	123.8289
Period 3	--	--	--	--
UNIT C				
Period 1	-0.1799	3.5566	-0.9630	19.7699
Period 2	--	--	--	--
Period 3	--	--	--	--
UNIT D				
Period 1	--	--	--	--
Period 2	--	--	--	--
Period 3	--	--	--	--

8

State of California

Department of Health Services

Memorandum

To : Maureen Higgins, Director
Department of Housing and
Community Development
P.O. Box 952051
Sacramento, CA 94252-2051

Date :

Subject: Administrative
Final February 1990
EIR

From : Health Hazard Assessment Division
714 P Street, Room 442
Sacramento, CA 95814
8/454-7572

At your request, staff of the Office Of Environmental Health Hazard Assessment have reviewed the Administrative Final February 1990 Environmental Impact Report: Expanded Uses of Plastic Plumbing Pipe, prepared for the Department of Housing and Community Development (HCD) by SRI International. As previously, we focused exclusively on the worker health and safety aspects of the Environmental Impact Report (EIR). Also as before, we paid particular attention to whether or not the EIR correctly reflected the data and conclusions of the worker exposure study conducted by the Department of Health Services (DHS) in 1988.

Summary

We appreciate that our comments on the previous Draft EIR have been addressed, and we think that the current version is a major improvement over the Draft EIR. However, we continue to have concerns in two of the major areas that we commented on before: 1) the EIR accurately summarizes the data from our 1988 study of worker exposures during plastic pipe installation, but reaches conclusions that are not supported by the data; and 2) the mitigation measures as recommended are not specific enough to assure that they will be effective in reducing the worker health risks, and must be strengthened to provide meaningful protection of worker health and safety. The current version of the EIR contains a small but important ambiguity about the necessity of implementing the individual mitigation measures. Specific comments on these issues are detailed below.

Overall we think that the Administrative Final EIR, if strengthened somewhat as recommended below, could be a sound, well-balanced document that strengthens HCD's position by addressing public concerns. We appreciate the opportunity to again comment on the EIR, and look forward to continuing to work with your department as this process evolves.

I. Data and conclusions on worker exposures

a. The Administrative Final EIR is considerably stronger than the Draft in its presentation of the available data on worker exposures during plastic pipe installation. However, the current version EIR curiously

leaves out the highest exposure levels measured during the DHS study (i.e. 529 ppm tetrahydrofuran and 160 ppm methyl ethyl ketone). The simple addition of these data would give readers a clearer indication of the exposure levels that can occur during plastic pipe installation.

b. The section on Cumulative and Long-Term Implications contains the sentence "However, although available toxicologic data are not complete, repeated exposure would probably not accumulate to serious, long-term risks." For tetrahydrofuran, "data are not complete" is a vast understatement. The conclusion that any health damage resulting from exposure "probably would not accumulate to serious, long-term risks," based on such limited data, is too strong.

c. The section on Significant Irreversible Changes contains the sentence "The expected more frequent exposure of plumbers to plastic pipe cement solvents would not be significant or irreversible." This sentence would be more accurate if it stated that the currently known health effects of such exposures are not irreversible. The exposures themselves, once they have occurred, cannot be reversed. If any irreversible toxicity is later found to be associated with exposure to these solvents, then workers who had been exposed might have sustained irreversible health damage.

d. The Summary of the Worker Safety and Health section is mostly accurate and well-balanced. However, the sentence "The potential for such systemic effects--especially after chronic exposure--has not been fully assessed in the plumbing environment." seems to us to imply that a lack of exposure information is what prevents a full assessment. This should be changed to indicate that the lack of toxicity information (especially for tetrahydrofuran) is the limiting factor in assessing health risk.

e. In the Conclusion (P. vi) the third sentence reads "worker exposure to solvents would increase, but could be limited to minor levels by the use of protective measures." The meaning of the term "minor" is unclear. We recommend that a more specific sentence be substituted.

Effectiveness of mitigation measures

Our concerns are in large part based on an over-reliance on Cal/OSHA in the face of serious limitations in Cal/OSHA resources.

a. Measure (1), "Strengthen Education and Training," states that "HCD will work with Cal/OSHA to define a means to ensure that employer education and training programs are in place." Unfortunately, Cal/OSHA has no means we are aware of, beyond enforcement of existing construction safety regulations or development and enforcement of a new specific standard, to ensure that employers provide education and training programs. We continue to believe that Cal/OSHA lacks resources for aggressive enforcement of training provisions, and promulgation of a

new specific standard, to ensure that employers provide education and training programs. We continue to believe that Cal/OSHA lacks resources for aggressive enforcement of training provisions, and promulgation of a new standard is unlikely. We think that the idea offered as an example, that "issuance of building permits to a licensed contractor could be made contingent on evidence that the contractor has an approved health and safety plan in place" is a sound concept. However, such a scheme would seem to depend mainly on action by HCD, acting in cooperation with local building officials. This plan, or some similar one, should be formalized explicitly in this Mitigation Measure, rather than referring the matter to an unspecified cooperative effort with Cal/OSHA. As we previously indicated, DHS would be willing to specify the elements that could be required to constitute a health and safety plan.

Even if an effective requirement for worker training programs was in place, however, the lack of good training resources would remain a problem. The current version of the EIR attempts to address this by stating that "HCD will request that cement manufacturers and plastic pipe and supplies distributors provide additional technical information." Our experience with employer-sponsored worker safety training programs is that their weaknesses rarely stem from a need for additional technical information. More often, the weaknesses of these programs are based on a shortage of good, well-trained trainers, on a lack of good, innovative training materials that adequately convey existing information, and on the small amount of time devoted to health and safety training. To address the shortages of good trainers and training materials, we think that HCD should press plastic pipe manufacturers and distributors to commit resources to creating effective training programs, rather than providing additional technical information. Training programs developed in this way could be disseminated for use by employers, contractors organizations, and labor organizations throughout the state.

b. The EIR in Mitigation Measure (3) states that HCD will initiate "the action necessary" to prohibit sale of DMF-containing primers and cements. This is the most strongly-worded action among the mitigation measures written for the Worker Safety and Health section. However, it still falls short of the unambiguous language used in other sections of the EIR. Consider, for example, Mitigation Measure (6), which is apparently imported from the Water Quality and Public Health section. This Measure specifically recommends a regulatory change, and says what that change should be. If HCD intends to make a regulatory change to prohibit DMF-containing plastic pipe products, then this section should be made more explicit.

c. Measure (4) of the Administrative Final EIR states that HCD "will work with Cal/OSHA to increase enforcement of ventilation requirements", and implies that Cal/OSHA will provide increased attention to instruction on ventilation through "a comprehensive alert." We know of no plans or mechanism for Cal/OSHA to actively engage in providing instruction on ventilation to plumbing contractors. Further, we doubt that significant increased enforcement is likely; Cal/OSHA's enforcement resources are already sufficiently strained that the vast majority of their enforcement actions are initiated by specific complaints. This is unlikely to change substantially unless Cal/OSHA is provided with additional resources. If HCD intends to augment Cal/OSHA resources to increase enforcement the Construction Safety Orders cited, then that should be specifically stated. Otherwise, we again urge that the EIR incorporate a role for local building inspectors-who already make frequent inspections at every construction site-in determining whether or not forced ventilation is being provided at sites where plastic pipe is being installed in enclosed spaces. The local building inspectors could be given enforcement authority through HCD-initiated regulation. Alternatively, a memorandum of understanding could be negotiated, under which the local building inspectors would check ventilation during their routine inspections and report apparent violations to Cal/OSHA, which would then follow-up with a prompt worksite inspection. This latter mechanism might be difficult to operate effectively, however, because construction workers move so frequently from site to site.

d. Measure (5) also relies heavily on Cal/OSHA to "remind employers " about the importance of using protective gloves and providing eyewash facilities. Again, we doubt that Cal/OSHA resources are sufficient to make implementation of this recommendation widespread or persistent. A role for local building officials would make this measure much more effective.

e. The Mitigation Measures in the Administrative Final EIR are much stronger than in the Draft, in large part because each measure now contains a sentence stating what actions HCD will take: "will request", "will work with", "will initiate the action necessary", etc. However, the current version does not make clear which of these action items represent HCD policy decisions and which are simply proposals made by HCD's EIR contractor. If some or all of the HCD actions in the mitigation measures are actually proposals rather than established policy, then these should be clearly distinguished.

3. Necessity for implementation of mitigation measures

In our previous comments, we noted that the EIR was ambiguous about whether or not the recommended mitigation measures were essential to protect worker health or whether they were desirable but optional. The current version is much improved, stating explicitly which mitigation measures fall into the two categories. However, the wording of the key paragraph (P. 79, last paragraph) is still somewhat confusing.

Once again, we appreciate the effort that HCD has put into improving the Worker Safety and Health section of the EIR, and are pleased that the EIR is much improved as a result of those efforts. We look forward to seeing the Final EIR, and to working further with HCD as the implementation of the mitigation measures proceeds. If you have any questions about these comments or related worker health and safety issues, please feel free to contact Dr. Linda Rudolph or Jim Bellows, of the DHS California Occupational Health Program, at (415) 540-2115 or ATSS 571-3448.

Steven A. Book, Ph.D., Chief

Attachments

State of California

Department of Health Services

Memorandum

To : Kenneth W. Kizer, M.D., M.P.H.
Director
8/1253

Date :

Subject: Comments on Plastic Pipe Environmental Impact Report

Via : Harvey F. Collins, Ph.D.
Deputy Director
Public Health
8/1353

From : Office of Environmental Health Hazard Assessment
8/442 4-7572

Attached is a copy of comments on the Draft Environmental Impact Report (DEIR) on the expanded use of plastic plumbing pipe. The DEIR was recently released by the Department of Housing and Community Development (HCD). Maureen Higgins, the Director of HCD, requested that the Department of Health Services provide comments on the DEIR. At your request, Office of Environmental Health Hazard Assessment staff reviewed the Worker Health and Safety sections of the DEIR and our comments were transmitted directly to Ms. Higgins. Our comments are based on the expertise developed by the staff of our branch during a study--conducted in cooperation with the California Public Health Foundation--of worker exposures during installation of plastic plumbing pipe. Other branches within the Department may be submitting comments on the sections of the DEIR relating to public drinking water safety.

Our comments reflect two main concerns with the DEIR. First, it understates the magnitude of chemical exposures that occur during plastic pipe installation, and underrates the potential health impacts of those exposures. Second, the DEIR presents a series of measures that could limit the exposures, but it provides no mechanisms for assuring that the hazard control measures would actually be implemented by a significant fraction of employers and employees in the construction industry. In our comments we have made specific suggestions for improving the DEIR in these areas.

If you have any questions please contact me.

Richard J. Jackson, M.D., M.P.H.
Chief

Attachment

State of California

Department of Health Services

Memorandum

To : Maureen Higgins, Director
Department of Housing and
Community Development
P.O. Box 952051
Sacramento, CA 94252-2051

Date :

Subject: Comments on
Plastic Pipe
Environmental
Impact Report

From : Office of Environmental Health
Hazard Assessment
714 P Street, Room 442
Sacramento, CA 95814
324-7572

At your request, staff of the Office of Environmental Health Hazard Assessment has reviewed the Draft Environmental Impact Report (DEIR) on the expanded use of plastic plumbing pipe, recently released by the Department of Housing and Community Development (HCD). Because we were involved (in cooperation with the California Public Health Foundation) in producing much of the information used for assessing worker health and safety impacts, we focused our review on the worker health and safety sections of the DEIR.

We have two fundamental concerns about the DEIR. First, it understates the magnitude of toxic chemical exposures found to occur during plastic pipe installation, and underrates the potential health impact of those exposures. Second, the DEIR alludes to a series of measures that could minimize these impacts, yet it provides no substantive recommendations about how HCD could assure that these measures would be implemented.

We believe that the exposures known to occur during installation of plastic plumbing pipe are significant enough that HCD must provide some mechanism for assuring, more directly, that the recommended control measures are adopted throughout the industry. The following are recommendations for strengthening the DEIR in these areas. We believe that methods for effectively implementing the hazard control measures must be incorporated into the DEIR, or the inadequacy of existing toxicity data may hinder acceptance of the final Environmental Impact Report.

1. State fully the extent of chemical exposures during installation of plastic plumbing pipe.

   The DEIR Summary correctly states that "installation using current procedures may cause short-term exposure limits to be exceeded one or more times on a substantial fraction of work days." However, the body of the DEIR fails to cite much of the strongest data from our worker exposure study. For example, the DEIR discusses the somewhat abstract concept of short-term exceedance probabilities, but nowhere mentions that worker exposures to tetrahydrofuran (THF) reached 529 ppm, more than twice the federal Permissible Exposure Limit. The DEIR does not clearly state that

workers installing plastic pipe for extended periods in highly-enclosed spaces are almost certain to experience repeated exposures above the *legal* exposure limit.

Similarly, the DEIR correctly states the highest measured exposures to THF and methyl ethyl ketone (MEK), 77% and 22.5% of their respective legal exposure limits. However, the DEIR does not point out that the highest measured exposure to all pipe cement solvents exceeded the exposure limit, based on an accepted index of combined exposure. Nor does it cite our estimate that workers installing chlorinated polyvinylchloride (CPVC) potable water pipe will be overexposed to these chemicals on approximately one of every ten work days.

Perhaps most importantly, the DEIR gives only brief mention to the importance of skin contact with plastic pipe cements and primers as a route of entry of toxic chemicals into the body. Specifically, the DEIR does not cite our data showing that some plumbers with heavy skin contact with cements and primers had concentrations of THF in their urine far in excess of the amount that would be expected from their airborne exposures alone. The estimated equivalent airborne THF exposures for these plumbers were up to 740 ppm, nearly four times the full-shift exposure limit. While the exact values are subject to some interpretation, these data give important evidence that some plumbers may absorb very substantial amounts of THF through their skin, and that the extent of skin contact must be given careful consideration when assessing overall exposure.

2. **State more clearly the inadequacy of available toxicity information, especially for THF, and the limits thus placed on assessing the health impact of documented exposures.**

The DEIR, in its summary of Cumulative and Long-Term Implications, acknowledges that the toxicologic data are not complete, yet asserts that "repeated exposure would probably not accumulate to serious, long-term health risks." In the case of THF, the chemical present at highest concentrations during CPVC water pipe installation, a statement that the toxicologic data are "not complete" seriously misrepresents the level of inadequacy. To our knowledge, *no* studies of the chronic toxicity of THF have been reported. Even the effects of short-term exposures at various exposure levels are relatively unknown in humans. Therefore, the ability of THF to cause such adverse health effects as cancer, nervous system damage, or reproductive toxicity must be considered unknown. The DEIR's conclusion that repeated exposure would "probably not accumulate to serious, long-term health risks" is entirely inappropriate. This unfounded assertion should be removed from the DEIR, especially from the sections on Cumulative and Long-Term Implications and on Significant Irreversible Changes.

Since the publication of our report on worker health hazards during plastic pipe installation, new information has been published about possible liver damage in workers exposed to THF (Garnier et al., Tetrahydrofuran Poisoning After Occupational Exposure. British Journal of Industrial Medicine 43: 577-78, 1989). This underscores the imprudence of assuming that long-term health risks would not be significant, in the absence of any chronic toxicity data. Forming public policy on such an assumption would be similarly imprudent.

Additionally, the consequence of repeated irritation of eyes, nose, and throat should not be lightly dismissed. A growing body of evidence suggests that repeated irritation may contribute to chronic illness (see, for example, Barnhart, S., Occupational Bronchitis: A Marker for Irritant Exposure. Seminars in Respiratory Medicine 7: 249-256, 1986 or Woutersen, R.A., et al., Nasal Tumors in Rats after Severe Injury to the Nasal Mucosa and Prolonged Exposure to 10 ppm Formaldehyde. Journal of Applied Toxicology 9: 39-46, 1986).

In a similar vein of underestimating the possible health impacts of documented risk factors, the DEIR states, in the Conclusion of the Worker Health and Safety section, that "increased use of plastic pipe may also lead to a decrease of unknown magnitude in the risk of accidental injury." This conclusion was apparently not based on any supporting evidence, and ignores two risk factors cited in our study that could well lead to an increase in serious accidents (namely, less-trained workers and a faster work pace).

Finally, the Worker Health and Safety section also concludes that "No major outbreaks of solvent-related illness are known among plumbers in California." While this may be a true statement, it is meaningless since no effort has been made to identify any such outbreaks or to compile cases of solvent-related illness among plumbers. It should be removed.

3. **The recommended measures for limiting exposures should be made much more concrete, and specific implementation proposals should be assessed to determine whether real improvements in working conditions and work practices would be made.**

The DEIR Summary concludes, in the worker health section, that "the occasionally excessive short-term exposures as well as total biological uptake could be reduced by instituting reasonable control measures that are not now widely used." However, unless HCD devises specific, effective implementation proposals, the hazard control recommendations included in the DEIR should not be expected to have much real impact on working conditions or exposure levels. In the absence of specific, effective implementation strategies, HCD must give much more serious consideration to the worker exposures, and possible health risks, likely to occur with increased use of plastic pipe.

Since the DEIR contains few concrete implementation proposals, we offer some possibilities below. Of course, numerous other strategies could also be devised. In any case, HCD should assess the ability of these strategies to assure safe and healthful working conditions.

On the subject of worker education and training, the DEIR states that "HCD could encourage primer and cement manufacturers and plastic pipe and supplies distributors to provide additional technical information to employers." Unfortunately, unavailability of technical information is not the weak link that prevents employers from mounting effective health and safety training programs. Rather, such programs are generally not offered because plumbing contractors have no background (and often no skill) in health and safety training, and because good training resources for plumbers are not generally available. Additionally, Cal/OSHA has previously devoted few of its limited resources to enforcement of training requirements in the current construction safety regulations, and lacks resources to enforce the training provisions aggressively in the near future.

To effectively implement a recommendation for better training, HCD could encourage or require plastic pipe manufacturers and distributors to commit substantial resources in an effort to create effective training programs for safe use of plastic pipe. These programs could be offered directly by the manufacturers and suppliers, or could be sponsored by these groups but provided by unions, contractors' associations, and private consultants.

Similarly, the DEIR properly points to plastic pipe installation in enclosed spaces as a particular problem area, and suggests that Cal/OSHA enforce existing regulations that require forced ventilation to reduce exposures to acceptable levels. However, Cal/OSHA enforcement resources are limited, so unless a specific agreement can be reached to focus enforcement efforts on these regulations, Cal/OSHA activity should not be relied upon to prevent installation of plastic pipe in enclosed areas or to assure that proper ventilation will be provided. We recommend that HCD consider a role for local building inspectors, who already make frequent inspections at every construction site. While these inspectors should not be expected to evaluate exposure levels, they could easily determine whether plastic pipe was being installed in enclosed areas and whether forced ventilation was provided. Perhaps HCD could devise a mechanism for granting some enforcement authority to local building inspectors, or a least a mechanism for assuring that appropriate referrals to Cal/OSHA were made.

The DEIR recommends adding worker health and safety questions to licensing examinations given by the Contractors State Licensing Board. Many contractors could be expected to answer these questions correctly, although they may not have effective health and safety programs for their workers. Therefore, this recommendation should be made more substantial. For example, individual plumbing contractors could be required to provide

documentation that they had instituted a comprehensive worker health and safety program whenever they applied for a building permit that called for installation of plastic pipe. At your request, we would be willing to specify the elements that could be required as part of a comprehensive health and safety training program.

The DEIR suggests that HCD recommend to the National Sanitation Foundation (NSF) that they prohibit use of dimethlyformamide in plastic pipe cements and primers, and that they require an addition of indelible dyes (to discourage skin contact to the few primers and cements that currently do not contain dyes). Such a recommendation may influence NSF, but certainly do not constitute a guarantee that these measures will be carried out. HCD should explore other measures that more directly assure these simple yet effective measures.

We recognize that the suggestions above imply a role for HCD in the area of worker health and safety that goes beyond its previous activities. Essentially, this expanded responsibility began with HCD's inclusion of worker health and safety in the environmental impact review process. However, we believe that the measures recommended above are feasible, and that in the absence of other effective means of protecting worker health they are also appropriate.

We would be happy to discuss these recommendations in greater detail, and look forward to continuing our productive working relationship with your Department.

Richard J. Jackson, M.D., M.P.H.
Chief

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Lewis R. Freeman, Jr.
Vice President
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August 9, 1994

Kenneth Kobrin
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Department of Housing and Community Development
State of California
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Sacramento, CA 94252-2052

Dear Ken:

I believe you are aware from conversations over the past several months with our attorney, Marcus Lo Duca of Weintaub Genshlea and Sproul, that SPI and the other parties interested in the pending Environmental Impact Report (EIR) on plastic pipe began searching early this year for an "EIR packager" to hire, pursuant to our agreement with you last year. Unfortunately, the best proposal we were able to obtain for such an undertaking was two to three times as much as our original cost estimates. Under those circumstances, we are unable to proceed with the project of hiring an outside party to complete the EIR.

SPI and those who have composed the coalition of interested companies and associations continue to believe that the ultimate responsibility for completing the EIR rests with the State of California. We have fulfilled all legal and financial obligations under the contract originally signed several years ago. Our attempt in early 1993 to fund additional work by an outside party so that the EIR could be certified was in recognition of the reality that 1) the Department of Housing and Community Development (HCD) did not have sufficient expertise or resources to do the work, and that 2) SRI International was not willing to do further work on the project, feeling the product it had produced met the letter of its agreement with HCD. However, we can no longer justify committing additional funds to the project when there is such uncertainty of the amount of funds needed and the outcome of any additional expenditures.

Effective immediately, SPI is suspending work on the project. In turn, we ask that HCD do nothing more in pursuit of an EIR on plastic pipe until you hear from us. If you have any questions please feel free to contact me directly.

Sincerely,

Lew

cc: California Pipe Group
Marcus Lo Duca, Weintaub Genshlea & Sproul
Peter de la Cruz, Keller and Heckman
Sue Fitchen, SRI International

CALIFORNIA BUILDING STANDARDS COMMISSION

Comments of THE COALITION FOR SAFE BUILDING MATERIALS on PROPOSED ADOPTION/APPROVAL OF AMENDMENT TO CALIFORNIA PLUMBING CODE TO AUTHORIZE USE OF CPVC PIPE	DECLARATION OF DANIEL L. CARDOZO IN SUPPORT OF COMMENTS OF THE COALTION FOR SAFE BUILDING MATERIALS Date: February 13, 1996

1. I am an attorney duly authorized to practice law in the State of California. I am a member of the firm of Adams & Broadwell and have represented the California Pipe Trades Council ("Council") in proceedings before the Department of Housing and Community Development ("HCD") with respect to expanded uses of plastic plumbing pipe. I have specifically represented the Council in HCD's plastic pipe EIR proceedings for the last ten years.

2. In the period following the submission of public comments on the Draft EIR in late 1989, I regularly telephoned the HCD Legal Office to monitor the status of the response to comments and the preparation of a Final EIR. During this period I was briefed on the status of the project by Dennis Beddard and Tom Infusino of the HCD's Legal Office. The Legal Office had been instructed by the Director of HCD to keep all parties apprised of the status of the Department's review and evaluation

of the comments. I maintained detailed notes of all conversations regarding the status of the project.

3. In conversations with the HCD Legal Office in late 1991 and early 1992, I was informed that the Attorney General's Office had completed its review of the Draft EIR and public comments, and had prepared a memorandum of over 100 pages describing its analysis and conclusions. I was informed that the Attorney General had concluded that the document was legally inadequate, and that substantial additional work and evaluation of the proposed project would be required to complete a document in compliance with the California Environmental Quality Act ("CEQA").

4. I was specifically informed by the HCD Legal Office that the Attorney General had concluded that the Draft EIR failed to identify potentially significant effects of the project as required by CEQA, failed to consider at all a number of important environmental impacts discussed in comments on the Draft EIR and failed to support its initial findings with an analytical foundation. I was also informed that the Attorney General had concluded that the environmental analysis presented in the Draft EIR would not provide an evidentiary basis for HCD to make the findings required by CEQA before approving the project.

5. I was also informed by the HCD Legal Office that HCD legal staff had concluded that the EIR was legally inadequate and would require substantial additional analysis by the EIR contractor. I was also informed by the HCD Legal Office that the

attorney representing the Society of the Plastics Industry had also concluded that the EIR failed to meet CEQA requirements.

I declare under penalty of perjury of the State of California that the foregoing is true and correct.

Executed on February 12, 1996 at South San Francisco, California.

Daniel L. Cardozo

A0391.031

EXPRESS TERMS
OF
PROPOSED BUILDING STANDARDS
OF THE
CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE,
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

NON-CONTROLLING PLAIN ENGLISH SUMMARY:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing homes to be initially installed with, or in the case of a failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe.

The proposed building standard regarding the California Plumbing Code, Part 5 of Title 24 of the California Code of Regulations (CCR) will alleviate unnecessary financial hardships caused by premature failure of metallic pipe in residential buildings. Specifically, it will permit the limited use of CPVC pipe in residential building where a local building official has determined that there is or will be a premature failure of metallic pipe and provided that the pipe is installed pursuant to specified mitigation measures.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the Department of Housing and Community Development (HCD) anticipates that the potential scope of CPVC use that will result from the proposed project will be limited. Information in the record of CPVC pipe indicates that problems with corrosive water and/or soils conditions exist throughout California, but is not a widespread problem. The evidence before HCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the HCD has concluded that the CPVC installations that may result from the proposed regulatory approval should be limited in scope.

The proposed building standard contain the following conditions:

1. A local building official would be authorized to approve the use of CPVC only if

that official determines that there is or will be a premature failure of metallic pipe due to water and/or soil conditions.

2. Any building permit issued by the local building official authorizing the use of CPVC would be conditioned on compliance with specific measures described in the regulations.
3. Only approved CPVC plumbing piping could be used.
4. Installation and use of CPVC would have to comply with all applicable requirements of the California Plumbing Code.
5. Prior to issuing a building permit authorizing use of CPVC, the contractor must provide certain written certifications.
6. Final permit approval cannot be given unless the material has been installed in compliance with the requirements of the California Plumbing Code.
7. A contractor not installing CPVC correctly would be subject to penalties.

EXPRESS TERMS:

Section 604.0 Materials
Section 604.1 Water pipe and fittings shall be of brass, copper, cast iron, galvanized malleable iron, galvanized wrought iron, galvanized steel, or other approved materials. Cast iron fittings used for water need not be galvanized if over two (2) inches (51 mm) in size. Asbestos-cement, CPVC, PE, or PVC water pipe manufactured to recognized standards may be used for cold water distribution systems outside a building. CPVC water pipe and tubing may be used for hot and cold-water distributions systems within a building. All materials used in the water supply system, except valves and similar devices shall be of a like material, except where otherwise approved by the Administrative Authority.

Section 604.1a [HCD 1 & 2] *Water pipe and fittings shall be of brass, copper, cast iron, galvanized malleable iron, galvanized wrought iron, galvanized steel, or other approved materials. Asbestos-cement, CPVC, PE, or PVC water pipe manufactured to recognize standards may be used for cold water distribution systems outside a building except as provided for CPVC use pursuant to section 604.1b. All materials used in the water supply system, except valves and similar devices shall be of a like material, except where otherwise approved by the Administrative Authority.*

Section 604.1b [HCD 1] Local Authority to Approve CPVC Pipe Within Residential Buildings Under Specified Conditions.
The local responsible building official of any city or county, in accordance with the procedures set forth in Chapter 3 (with the exception of section 301.2.7) may authorize by permit the use of CPVC for hot and cold-water distribution systems within the interior

of residential buildings provided all of the following conditions are satisfied:

(a) ***Finding Required.*** *The building official shall first make a determination that there is or will be the premature failure of metallic pipe if installed in such residential buildings due to existing water or soil conditions.*

(b) ***Permit Conditions.*** *Any building permit issued pursuant to this section shall be conditioned on compliance with the mitigation measures set forth in this section.*

(c) ***Approved Materials.*** *Only CPVC plumbing material listed as an approved material in, and installed in accordance with this code may be used.*

(d) ***Installation and Use.*** *Any installation and use of CPVC plumbing material pursuant to this section shall comply with all applicable requirements of this code and Section 301.0 of Appendix I of this code, Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distributions Systems, IAPMO IS 20-96.*

(e) ***Certification of Compliance.*** *Prior to issuing a building permit pursuant to this section, the building official shall require as part of the permitting process that the contractor, or the appropriate plumbing subcontractors, provide written certification: (1) that is required in subdivision (f); and (2) that he or she will comply with the flushing procedures and worker safety measures set forth in Section 301.0 of Appendix I of this code, Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems IAPMO IS 20-96.*

(f) ***Worker Safety.*** *Any contractor applying for a building permit that includes the use of CPVC plumbing materials authorized pursuant to this section shall include in the permit application a signed written certification stating that:*

(1) They are aware of the health and safety hazards associated with CPVC plumbing installations.

(2) They have included in their Illness and Injury Prevention Plan the hazards associated with CPVC plumbing pipe installations; and

(3) The worker safety training elements of their Injury and Illness Prevention Plan meets the Department of Industrial Relation's guidelines.

(g) ***Findings of Compliance.*** *The building official shall not give final permit approval of any CPVC plumbing materials installed pursuant to this section unless he or she finds that the material has been installed in compliance with the requirements of this code and that the installer has complied with the requirements in section 301.0.1, of Appendix I of this code, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, IAPMO IS 20-96.*

(h) ***Penalties.*** *Any contractor or subcontractor found to have failed to comply with the ventilation, glove or flushing requirements of section 301.0 of Appendix I of this code, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, IAPMO IS 20-96 shall be subject to the penalties in Health and Safety Code, division 13, part 1.5, chapter 6 (section 17995 et seq). In addition, if during the conduct of any building inspection the building official finds that the ventilation and glove requirements of section 301.0 of Appendix I of this code, Special Requirements for CPVC Installation within Residential Buildings, are being*

violated. such building officials shall cite the contractor or subcontractor for that violation.

Note: [For HCD 1 & 2] CPVC installations shall be subject to the work practices established in the California Health and Safety Code, Division 13, Part 1.5, Section 17291.9.

Section 301.0 Special Requirements for CPVC Installation Within Residential Buildings Only. [HCD 1]

In addition to the other requirements in the California Plumbing Code and this Appendix for the Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distributions Systems, all installations of CPVC pipe within residential structures shall meet the following.

301.0.1 Flushing Procedures.

301.0.1.1 All installations of CPVC pipe within residential structures shall be flushed twice over a period of at least one week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. At the time of the fill, each fixture shall have a removable tag applied stating:

"This new plumbing system was first filled on (date) by (name). The California Department of Housing and Community Development requires that the system be flushed after standing at least one week after the fill date specified above. If the system is used earlier than one week after the fill date, the water must be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to flushing, except by the homeowner."

301.0.2 Worker Safety Measures.

301.0.2.1 Mechanical ventilation sufficient to maintain exposures below the relevant exposure limits established by state regulations shall be provided in enclosed spaces. This ventilation shall be directed at the breathing zone of the worker installing the pipe. Where mechanical ventilation is not practical, respirators, suitable for organic vapors, shall be used. For the purpose of this subdivision, and enclosed space is defined as:

(a) A space less than 100 square feet of floor area under a ceiling with a height of 10 feet or less, and which does not have openings

(consisting of doors, windows, or unfinished walls) on at least two sides;

(b) Crawl spaces having a height of less than three feet;

(c) Enclosed attics that have a roof and ceiling; or

(e) Trenches having a depth greater than twenty-four inches.

3.01.0.2.2 Installers of CPVC pipe within residential structures shall use non-latex thin gauge (4 millimeters) nitrile gloves, or other gloves providing an equivalent or better degree of protection during the installation of the CPVC plumbing system. Gloves shall be provided to all workers by the contractor, or plumbing subcontractor, and shall be replaced upon contamination by cements.

Section 301.1 Minimal Standards

3011.1. Materials shall comply with the following . . .

Primer 1 - Listed primers shall be used . . .

301.1.2.3 Solvent Cement . . .

301.1.2.4.1 Primer . . .

Section 316.1 Solvent Cement Joints

316.1.1 Safety Requirements and Precautions (*FN from Appendix of XI ASTM 2564-88*)

(b) Use of ventilating devices.

(c) Proper eye protection

(g) Proper gloves impervious to and unaffected by . . .

316.1.1.1 Selection. Follow manufacture recommendations

316.1.1.3 Primer Listed primer in compliance with ASTM F 656-93

609.0 Installation, Inspection and Testing

- Location Prohibition
- Water Heater distance limitation
- Identification
- Testing - no air testing allowed.

INITIAL STATEMENT OF REASONS
FOR
PROPOSED BUILDING STANDARDS
OF THE
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
REGARDING THE CALIFORNIA PLUMBING CODE,
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5.

The Administrative Procedure Act requires that an Initial Statement of Reasons be available to the public upon request when rulemaking action is being undertaken. The following are the reasons for proposing this particular rulemaking action:

On November 14, 2000, the California Building Standards Commission approved emergency regulations to the California Plumbing Code (CPC), which were effective immediately and allowed the limited use of chlorinated polyvinyl chloride (CPVC) pipe in residential buildings in California. These emergency regulations are in effect for only 120 days. During this period the Department of Housing and Community Development (HCD) is required to submit this regular building standard package to the Commission for formal adoption of the CPVC regulations into the CPC. The proposed building standard for this submittal package is identical to what the Commission approved as an Emergency Regulation on November 14, 2000.

ADOPTIONS, AMENDMENTS, OR REPEALS:

Part 5, Section 604.1b and Section 301.0 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems

1) The public problem that the proposed code change is intended to address.

Problem with Metallic Pipe Corrosion: Various areas of the state are experiencing premature failure of metallic pipe in residential buildings. Information in the record of previous HCD examinations of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist in various regions throughout California, but are not widespread. The evidence before HCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential buildings are being served by underground water wells. HCD has determined that at least 16 different counties in California, from southern to northern California, have areas where there are corrosive water and/or soil conditions that have cause premature failure of the existing metallic pipe in residential homes.

Declaration adopted by HCD on November 8, 2000. The building standard will allow local building officials to permit the use of CPVC pipe in residential hot and cold water plumbing systems upon a finding by the local building official that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions. Pursuant to the settlement agreement, the approved building standard requires specific conditions and mitigation measures to be implemented by HCD, the Department of Industrial Relations, and local building officials, including the requirements that HCD issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. The required Information Bulletin was issued by HCD on December 13, 2000. Finally, the settlement agreement also provides for HCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Requirements of Mitigated Negative Declaration: As noted above, a Mitigated Negative Declaration was adopted by HCD on November 8, 2000.[3] The Mitigated Negative Declaration found that given the limited scope of the project, and/or provided the proposed mitigation measures were complied with, the implementation of the building standard would not result in any significant environmental impacts or potential health hazards to the homeowner or installer of the CPVC pipe. As part of HCD's adoption of the Mitigated Negative Declaration, the adopted building standard must include the mitigation measures discussed in the Mitigated Negative Declaration.

Adoption of Emergency Regulations. Due to the urgency to provide a solution for metallic pipe failure in residential buildings, the California Building Standards Commission approved an emergency regulation on November 14, 2000 to the California Plumbing Code (CPC), which was effective immediately and allowed the limited use of CPVC pipe in residential buildings in California. These emergency regulations are in effect for only 120 days. During this period the HCD is required to submit this regular building standard package to the Commission for formal adoption of the CPVC regulations into the CPC. The proposed building standard for this submittal package is identical to what the Commission approved as an Emergency Regulation on November 14, 2000.

2) Specific purpose and rationale for necessity of the proposed code change.

Purpose of: Section 604.1b and Section 301.0 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems.

Pursuant to the court's order in *Cuffe v. California Building Standards Commission, et al.*, see supra note 1, the settlement agreement, and the approved Mitigated Negative Declaration discussed above, HCD has developed the proposed building standard allowing the limited use of CPVC in residential buildings. The purpose of the proposed building standard is to give new home buyers and existing homeowners a permanent solution to the recurring problem of premature metallic pipe failures by allowing the

3 HCD approved Mitigated Negative Declaration, November 8, 2000, titled "Regulations for the Limited Use of CPVC for Residential Buildings:" SCH# 2000091089.

limited use of CPVC pipe. HCD is proposing to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems."

As discussed above, due to the urgency to provide a solution for metallic pipe failure in residential buildings, the California Building Standards Commission approved an emergency regulation on November 14, 2000 to the CPC), which were effective immediately and allowed the limited use of CPVC pipe in residential buildings in California. (These emergency regulations are in effect for only 120 days and require formal adoption by the Commission). If formally adopted by the Commission, the proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings if the official has determined that there is or will be a premature failure of metallic pipe due to corrosive water and/or soil conditions. The proposed building standard is subject to specific conditions and includes the mitigation measures from the Mitigated Negative Declaration.

Rationale for Necessity of: Section 604.1b and Section 301.0 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems

HCD has determined that it is necessary to adopt the proposed sections and incorporate them into the California Plumbing Code (CPC) because the clock is ticking for those homeowners in the state that will be facing the need to re-pipe because of the premature failure of metallic pipe in their homes. Also, as discussed above, the already-approved emergency building standard is in effect for only 120 days. Formal adoption by the Commission is required in order for this building standard to become permanent.

Without approval of this building code these homeowners will face a range of costs that will undoubtedly present a financial hardship to them, as the cost was not anticipated when the house was purchased. These homeowners will not have the option to use CPVC pipe, and will be forced to replace the failed metallic pipe with similar metallic pipe that is susceptible to the same corrosive problems that caused the premature failure to occur. This will also cause the homeowner unnecessary exposure to potential health problems associated with corroded metals in their drinking water. Furthermore, without approval, any new homes built in areas with corrosive water and/or soil conditions will be forced to use metallic pipe, which would likely need replacement in a few years if premature failure occurs. Besides the potential health hazards associated with using metal-contaminated water for drinking and other residential purposes, the receiving waters will in turn continue to be contaminated with the metal-contaminated drinking/residential water if CPVC piping material is not permitted under the CPC.

The proposed action is to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I,

"Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems." These new sections incorporate specific mitigation measures that are necessary to comply with the CEQA requirements for the November 2000 approved Mitigated Negative Declaration.

Section 604.1b is the language necessary for the implementation and enforcement of the requirements of the settlement agreement and Mitigated Negative Declaration:

Subpart (a) sets forth the requirement for the findings by the local building official of premature failure of metallic pipe prior to allowing CPVC as an alternative.

Subpart (b) sets forth the requirement that the permit issued for CPVC use in residential buildings be conditioned on compliance with the mitigation measures of the Mitigated Negative Declaration.

Subpart (c) sets forth the requirement that the CPVC pipe must comply with all other requirements in the CPC.

Subpart (d) sets forth the requirement that the CPVC pipe must comply with the requirements in Section 301.0 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems.

Subpart (e) sets forth the requirement that prior to issuing a building permit, the building official shall require written certification from the contractor/subcontractor for worker safety and for compliance with the mitigation measures in Section 301.0 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems.

Subpart (f) sets forth the requirements for the required certification statement required in Subpart (e).

Subpart (g) sets forth the requirement that the building official shall not give final permit approval for CPVC installation unless the building official finds that the material has been installed in compliance with all CPC requirements in the code and with the flushing procedures in Section 301.0.1 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems.

Subpart (h) sets forth the penalties to be administered if the contractor/subcontractor has failed to comply with the flushing and worker safety requirements in Section 301.0 of Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems. This subpart also requires that the building official cite the contractor/subcontractor if they are in violation of the ventilation and glove requirements of Section 301.0.

Section 301.0 of Appendix I. Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems is the language necessary for the implementation and enforcement of the requirements of the settlement agreement and Mitigated Negative Declaration:

Section 301.0.1 sets forth the requirement for flushing of the newly installed CPVC piping and the use of a removal tag as required by the Settlement Agreement and the approved Mitigated Negative Declaration as discussed above.

Section 301.0.2 sets forth the requirement for worker safety measures for the installation of the CPVC piping as required by the Settlement Agreement and the approved Mitigated Negative Declaration as discussed above.

AN IDENTIFICATION OF EACH TECHNICAL, THEORETICAL, AND EMPIRICAL STUDY, REPORT, OR SIMILAR DOCUMENT UPON WHICH THE AGENCY IS RELYING IN PROPOSING THE ADOPTION, AMENDMENT, OR REPEAL.

HCD approved Mitigated Negative Declaration, November 8, 2000, titled "Regulations for the Limited Use of CPVC for Residential Buildings:" SCH# 2000091089.

ALTERNATIVES TO THE REGULATION

Due to the many years of litigation concerning the approval of CPVC pipe for residential use, no other alternatives were considered by HCD. As discussed above, the proposed building standard has been subject to various lawsuits and the proposed language is the result of a court approved settlement agreement and an approved Mitigated Negative Declaration.

ALTERNATIVES THE (AGENCY) HAS IDENTIFIED THAT WOULD LESSEN ANY ADVERSE IMPACT ON SMALL BUSINESS.

HCD has determined that given the limited scope of the proposed building standard there is no adverse impact on small business.

FACTS, EVIDENCE, DOCUMENTS, TESTIMONY, OR OTHER EVIDENCE OF NO SIGNIFICANT ADVERSE ECONOMIC IMPACT ON BUSINESS.

The potential scope of CPVC use that will result from the proposed building standard should be limited because the information in the record indicates that metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence before HCD indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water

wells and that the resulting installation of CPVC pipe in California from the proposed regulatory approval will be limited in scope.

- To the extent that CPVC plastic pipe is authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, there could be some reduction in the business of California metallic pipe manufacturers, distributors, and retailers. However, these potential losses would be offset by gains in the business of CPVC plastic pipe manufacture, distribution and retailing. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduced the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the HCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

DUPLICATION OR CONFLICTS WITH FEDERAL REGULATIONS

HCD has determined that this proposal does not conflict with nor duplicate Federal Regulations.

EFFECT ON PRIVATE PERSONS

The proposed building standard is not mandatory and only provides an alternative to those persons who have metallic pipe corrosion problems in their residential building. No alternative considered by the agency would be more effective in carrying out the purpose for which the regulation is proposed or would be as effective and less burdensome to affected private persons than the proposed regulation.

SPECIFIC TECHNOLOGY OR EQUIPMENT

The proposed building standard is not mandatory and only provides an alternative to those persons who have metallic pipe corrosion problems in their residential buildings. Because of the years of litigation concerning the approval of CPVC pipe as an alternative material in the CPC, no other alternatives were considered by HCD. As discussed above, the proposed building standard has been subject to various lawsuits and the proposed language is the result of a court approved settlement agreement among the opposing parties of the lawsuit.

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF CODES AND STANDARDS
1800 THIRD STREET, SUITE 260, P.O. BOX 1407
SACRAMENTO, CALIFORNIA 95812-1407
(916) 445-9471 FAX (916) 327-4712
From TDD Phones 1 (800) 735-2929

There were no written comments, objections or recommendations received regarding the proposed regulations during the 45-day Public Comment Period.

There was a request (the FAX-MEMO is included in this section of the Rule Making File) from James Herota, Analyst, Regulation Review Unit the California Technology, Trade and Commerce Agency for a copy of a document.

California Technology, Trade and Commerce Agency
Office of Economic Research
801 K Street, Suite 1700
Sacramento, California 95814

Voice: (916) 322-3578
Fax: (916) 322-0669

Fax Transmittal

Date : February 21, 2001

Pages to Follow: 1

To: **Mr. William J. Staack, Staff Counsel**
Division of Legal Affairs
Department of Housing and Community Development
1800 Third Street, Suite 400
Sacramento, California 95814

Fax: (916) 323-7288
Voice: (916) 323-2815

From: **James Herota, Analyst**
Regulation Review Unit

Subject: Proposed Regulations in Title 24 Limited Use of CPVC Pipe in Residential Buildings (OAL *Notice* File #Z00-1227-01)

Please see attachment.

California Technology, Trade and Commerce Agency
Regulation Review Unit
801 K Street, Suite 1700
Sacramento, California 95814

Phone: (916) 323-0484
Fax: (916) 322-0669

Regulation Review Comments

Date: February 20, 2001

Total Pages Faxed: 1

TO: Mr. William J. Staack, Staff Counsel
Division of Legal Affairs
Department of Housing and Community Development
1800 Third Street, Suite 400
Sacramento, California 95814

Phone: (916) 323-7288
Fax: (916) 323-2815

FROM: James Herota, Analyst
Regulation Review Unit

SUBJECT: **Proposed Regulations in Title 24, Limited Use of CPVC Pipe in Residential Buildings (OAL *Notice* File #Z00-1227-01)**

This memo is to confirm our February 1, 2001 telephone conversation regarding the following document referenced in the Notice: "Department of Housing and Community Development evaluation of the effect of the proposed regulatory action on housing costs." When RRU requested a copy of that document, you stated the citation was an error and that the document did not exist. You also stated that the error would be corrected in the final statement of reasons.

Thank you for your assistance in this matter.

UPDATED INFORMATIVE DIGEST
FOR
PROPOSED BUILDING STANDARDS
OF THE
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE

CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

Summary of Existing Laws

The purpose of these building standards is to implement, interpret, and make specific the provisions of Health and Safety Code Sections 17921 and 17922 of the State Housing Law.

- Health and Safety Code Section 17921 requires that HCD propose the adoption, amendment, or repeal of building standards to CBSC for the protection of the public health, safety and the construction, repair and maintenance of all hotels, motels, lodging houses, apartment houses and dwellings.

- Health and Safety Code Section 17922 (a) requires that HCD propose the adoption of uniform industry codes, including the Uniform Plumbing Code (UPC) published by the International Conference of Building Officials (ICBO) and the International Association of Plumbing and Mechanical Officials (IAPMO).

The Department of Housing and Community Development (HCD) has been directed by the Legislature to propose for adoption in the California Plumbing Code, substantially as published, uniform industry codes, including the Uniform Plumbing Code (UPC) published by the International Association of Plumbing and Mechanical Officials (IAPMO) (Health and Safety Code sec. 17922(a)). Beginning with the 1982 edition of the UPC, chlorinated polyvinyl chloride (CPVC) plastic pipe was permitted for use inside residential buildings for hot and cold-water distribution. However, the predecessor to the California Building Standards Commission (CBSC) determined that an Environmental Impact Report (EIR) prepared pursuant to the requirements of the California Environmental Quality Act (CEQA) was needed before approving this expanded use of CPVC plastic pipe in the California Building Code. As part of the adoption of the 1982 UPC, HCD proposed and the CBSC adopted California Plumbing Code section 604.1a, which prohibits the use of CPVC for hot and cold-water distribution within residential buildings in California pending compliance with CEQA. Section 604.1a has remained a part of the California Plumbing Code ever since, even though each successive edition of the UPC has permitted this use of CPVC. The rationale for the continuing prohibition in the California Plumbing Code was the delayed completion of the EIR.

In October 1995, AB 151 (Stats. 1995. c. 785) was signed into law and allowed the use of CPVC plastic pipe as an alternate building material in residential buildings under specified conditions. HCD subsequently filed and the CBSC subsequently approved emergency regulations, which had the effect of permitting the use of CPVC plastic pipe for hot and cold-water distribution inside buildings on a statewide basis. This action was successfully challenged in court on the ground that the decision to allow the expanded use of CPVC plastic pipe was a discretionary action subject to the requirements of CEQA. (*Cuffe* v. *California Building Standards Commission and the California Department of Housing and Community Development* (Superior Court of San Francisco, File No. 300221).)
In compliance with the court's order, HCD performed a preliminary environmental assessment and determined that it would be prudent to prepare a full environmental impact report. HCD completed and certified an EIR (The Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings; State Clearinghouse Number 90820040; prepared by the Department of Housing & Community Development and certified December 1, 1998, hereinafter referred to as the "CPVC EIR"). The CPVC EIR concluded that permitting the use of CPVC plastic pipe for statewide use for hot and cold-water distribution within residential buildings would not result in any significant environmental impacts.

A court challenge to the 1998 certified CPVC EIR resulted in a settlement agreement to allow the limited use of CPVC pipe in residential buildings. This regulatory proposal and a November 2000 Certified Negative Declaration with Mitigation Measures have been prepared pursuant to this settlement agreement. The Certified Negative Declaration satisfies the CEQA requirement of the court in *Cuffe* v. *California Building Standards Commission, et al.*, see *supra*. The finding of the Negative Declaration for the proposed building standard was that given the limited scope of the project, and/or provided the proposed mitigation measures were complied with, the implementation of the building standard would not result in any significant environmental impacts or potential health hazards to the homeowner or installer of the CPVC pipe. The settlement agreement provides for rescission of the 1998 certified CPVC EIR and withdrawal of the previous proposed building standard approving CPVC use on a statewide basis. The settlement agreement would allow a building standard for the limited use of CPVC pipe in residential buildings upon a finding by the local building official that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions. The settlement agreement required specific conditions and mitigation measures to be included in the building standard and also provides that HCD issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. Furthermore, the settlement agreement also provides for HCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Summary of Existing Regulations

The Uniform Plumbing Code section 604.1 permits this use of CPVC plastic pipe in residential buildings; however, HCD did not adopt section 604.1. HCD adopted an amendment, section 604.1a into the California Plumbing Code, Title 24, Chapter 6, that does not permit the use of CPVC plastic pipe for purposes of hot and cold-water distribution within residential buildings (HCD 1 and HCD 2 occupancies).

Summary of Effect

The proposed action is to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems." These new sections incorporate specific mitigation measures that are necessary to comply with the CEQA requirements for the November 2000 certified Negative Declaration with Mitigation Measures.

If adopted, the proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings subject to specified conditions and mitigation measures that are incorporated into the regulatory proposal. A local building official would be authorized to approve the use of CPVC only if he or she first determines that there is or will be a premature failure of metallic pipe if installed in such residential buildings due to corrosive water and/or soil conditions. Any building permit issued by the local building official authorizing the use of CPVC based on such a finding would be conditioned on compliance with the specific mitigation measures in the building standard.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the potential scope of CPVC use that will result from the proposed building standard will be limited. Information in the record of previous HCD examinations of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before HCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the HCD has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

Comparable Federal Statute or Regulations

CPVC pipe is approved for use in manufactured residential homes for hot and cold-water distribution systems through the federal National Manufactured Housing Construction and

Safety Standards Act of 1974. This Act preempts state regulations of manufactured housing construction standards.

Small Business Affect

As discussed above in the "Summary of Effect," the potential scope of CPVC use that will result from the proposed building standard should be limited because the information in the record indicates that metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence before HCD indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. HCD has made a determination that CPVC pipe is an effective alternative building material in those areas of the state with corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure. For these reasons, the HCD has concluded that CPVC pipe is an acceptable alternative for premature failed metallic pipe, but that the resulting installation of CPVC pipe in California from the proposed regulatory approval will be limited in scope.

To the extent that CPVC plastic pipe is authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, there could be some reduction in the business of California metallic pipe manufacturers, distributors, and retailers. However, these potential losses would be offset by gains in the business of CPVC plastic pipe manufacture, distribution and retailing. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduce the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the HCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

Policy Statement Overview:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing the homes to be initially installed with, or in the case of failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe.

The proposed building standard regarding the California Plumbing Code, Part 5 of Title 24 of the California Code of Regulations (CCR) will alleviate unnecessary financial hardships caused by premature failure of metallic pipe in residential buildings. Specifically, they will permit the limited use of CPVC pipe in residential building where it is determined by a local building official that there is or will be the premature failure of metallic pipe and the pipe is installed pursuant to specified mitigation measures.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the potential scope of CPVC use that will result from the proposed building standard will be limited. Information in the record of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before the Department of Housing and Community Development (HCD) indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the HCD has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

The proposed building standard contains the following conditions:

1. A local building official would be authorized to approve the use of CPVC only if that official determines that there is or will be a premature failure of metallic pipe.
2. Any building permit issued by the local building official authorizing the use of CPVC would be conditioned on compliance with specific measures described in the regulations.
3. Only approved CPVC plumbing piping could be used.
4. Installations and uses of CPVC would be required to comply with all applicable requirements of the California Plumbing Code.
5. Prior to issuing a building permit authorizing use of CPVC, the contractor must provide certain written certifications.
6. Final permit approval cannot be given unless the material has been installed in compliance with the requirements of the California Plumbing Code.
7. A contractor not installing CPVC correctly would be subject to penalties.

FINAL STATEMENT OF REASONS
FOR
PROPOSED BUILDING STANDARDS
OF THE
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
REGARDING THE CALIFORNIA PLUMBING CODE,
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5.

The Administrative Procedure Act requires that an Final Statement of Reasons be available to the public upon request when rulemaking action is being undertaken. The following are the reasons for proposing this particular rulemaking action:

UPDATES TO THE INITIAL STATEMENT OF REASONS:

There are NO CHANGES to the Initial Statement of Reasons. On November 14, 2000, the California Building Standards Commission approved emergency regulations to the California Plumbing Code (CPC), which were effective immediately and allowed the limited use of chlorinated polyvinyl chloride (CPVC) pipe in residential buildings in California. These emergency regulations are in effect for only 120 days. During this period the Department of Housing and Community Development (HCD) is required to submit this regular building standard package to the Commission for formal adoption of the CPVC regulations into the CPC. The proposed building standard for this submittal package is identical to what the Commission approved as an Emergency Regulation on November 14, 2000.

MANDATE ON LOCAL AGENCIES OR SCHOOL DISTRICTS:

The Department of Housing and Community Development has determined that the proposed regulatory action WOULD NOT impose a mandate on local agencies or school districts.

PRIVATE PERSONS:

The Department of Housing and Community Development has determined that no alternative considered be more effective in carrying out the purpose for which the regulation is proposed or would be as effective and less burdensome to affected private persons than the proposed regulation.

Due to the many years of litigation concerning the approval of CPVC pipe for residential use, no other alternatives were considered by HCD. As discussed in the record, the proposed building standard has been subject to various lawsuits and the proposed language is the result of a court approved settlement agreement and an approved Mitigated Negative Declaration. HCD approved Mitigated Negative Declaration, November

8, 2000, titled "Regulations for the Limited Use of CPVC for Residential Buildings:" SCH# 2000091089.

ADVERSE ECONOMIC IMPACT ON SMALL BUSINESSES:

HCD has determined that given the limited scope of the proposed building standard there is no adverse impact on small business. The potential scope of CPVC use that will result from the proposed building standard should be limited because the information in the record indicates that metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence before HCD indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells and that the resulting installation of CPVC pipe in California from the proposed regulatory approval will be limited in scope.

To the extent that CPVC plastic pipe is authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, there could be some reduction for small businesses of California metallic pipe manufacturers, distributors, and retailers. However, these potential losses would be offset by gains for small businesses of CPVC plastic pipe manufacture, distribution and retailing. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduced the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the HCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

OBJECTIONS OR RECOMMENDATIONS MADE REGARDING THE PROPOSED REGULATIONS.

There were NO OBJECTIONS OR RECOMMENDATIONS made regarding the proposed regulations during the 45-day Public Comment Period.

There was a request (the fax is included in the Written Comment section of the Rule Making File) from James Herota, Analyst, Regulation Review Unit the California Technology, Trade and Commerce Agency for a copy of a document. This document was cited in the "Notice of Proposed Action" on page 9 0f 10 under the following heading:

"SIGNIFICANT EFFECT ON HOUSING COSTS

The DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT has made an initial determination that this proposal WOULD NOT have a significant effect on housing costs. The CBSC contact designated below will make the DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT evaluation of the effect of the proposed regulatory action on housing costs available upon request."

As noted in the FAX-MEMO sent by Mr. Herota, HCD discussed with Mr. Herota, that HCD had made an initial determination that the CPVC regulations would not have a significant effect on housing costs. However, the second sentence about the availability of this evaluation with the CBSC was mistakenly included with HCD's determination statement. This statement was a typo and should not have been included. HCD's initial determination of "significant effect on housing costs" was based on the record which includes the Mitigated Negative Declaration and its supporting documentation and the Rule Making File for the CPVC regulations.

Mr. Herota FA-MEMO stated, "You also stated that the error would be corrected in the final statement of reasons." Since the subject sentence appears only in the "Notice of Proposed Action" it cannot be corrected in the Final Statement of Reasons" other that the above explanation which is part of the Final Statement of Reasons.

STATE OF CALIFORNIA-BUSINESS, TRANSPORTATION, AND HOUSING AGENCY
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
Office of the Director
1800 Third Street, Suite 450
P. O. Box 952051
Sacramento, CA 94252-2051
http://housing.hcd.ca.gov
(916) 445-4775

June 27, 2000

Travis Pitts
Executive Director
California Building Standards Commission
1130 K Street, Suite 101
Sacramento, CA 95814

-- by facsimile & regular mail --
(916) 443-6008

Re: Department of Housing & Community Development's Proposed Amendment to the California Plumbing Code Concerning Chlorinated Polyvinyl Chloride (CPVC) Pipe

Dear Travis:

The Department hereby withdraws its proposed amendments to section 604 of the California Plumbing Code previously filed with the Commission and identified as item 31 in the Commission's Monograph of Code Change Submittals for 1999. Thank you for your consideration.

Sincerely,

Jack Nunis for
Julie Bornstein, Director
Department of Housing and
Community Development

cc: Norman A. Sorensen
Robert Keefe
Bruce McKarley
Patricia Neal
Richard Friedman
Bill Staack

STATE OF CALIFORNIA - BUSINESS, TRANSPORTATION AND HOUSING AGENCY GRAY DAVIS, GOVERNOR
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
Division of Legal Affairs
1800 Third Street, Suite 440
P.O. Box 952052
Sacramento, CA 94252-2052
(916) 323-7288
FAX (916) 322-2815

October 24, 2000

OFFICE OF THE STATE FIRE MARSHAL
Regulations Unit
John K. Guhl, Deputy State Fire Marshal III
P.O. Box 944246
Sacramento, CA 94244-2460

Re: Submission of Emergency Regulations for the Limited Use of Chlorinated Polyvinyl Chloride (CPVC) Pipe for Potable Water Piping in Residential Buildings

Dear Mr. Guhl;

The California Department of Housing and Community Development (DHCD) has submitted the attached Emergency Regulation package to the Building Standards Commission in preparation for their November 14, 2000 Hearing. The Emergency Regulation Package is for adoption of regulations into Title 24, California Plumbing Code. These regulations are for statewide application and would expand the use of Chlorinated Polyvinyl Chloride (CPVC) pipe as an alternative material in residential buildings. CPVC pipe will be permitted for potable water piping only in those situations where the local building official has made a determination that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions and the installation is in compliance with specific mitigation measures.

Government Code section 11359 specifies that a regulation *"intended to promote fire and panic safety or provide fire protection and prevention, including fire suppression systems, equipment, or alarm regulation,"* is not valid "*...unless... approved in writing by, the State Fire Marshal before transmittal to...the Secretary of State or Office of Administrative Law.*" DHCD has determined that the attached regulation does not promote fire and panic safety and no written approval is required from the Office of the State Fire Marshal.

Enclosed are one Face Sheet, and a copy of the Finding of Emergency, Express Terms, and Nine-Point Criteria Analysis as required for submission of this Emergency Package to the Building Standards Commission. If you have any questions or comments, please contact me at (916) 323-7288.

Sincerely,

William J. Staack

William J. Staack, Esq., P.E.
Staff Counsel

Enclosures

State of California
State and Consumer Services Agency

California Building Standards Commission
1130 K Street, Suite 101, Sacramento, CA 95814
(916) 323-6363; FAX (916) 443-6008

Memorandum

Date: October 24, 2000

To: William J. Staack, Esq., P.E.
Staff Council
Housing and Community Development (HCD)

From: **Stan Nishimura**
Executive Director

Subject: Emergency Regulations for the Limited Use of Chlorinated Polyvinyl Chloride (CPVC) Pipe for Potable Water Piping in Residential Buildings

The purpose of this memorandum is to inform HCD that Building Standards Commission staff has reviewed the above mentioned emergency code change submittal and has indicated that this submittal complies with the California Code of Regulations (CCR), Title 24, Part 1, Section 1-402 (b). The Commission at its regular meeting on November 14, 2000 will hear the proposed "Emergency" regulations. This meeting will begin at 10:00 a.m. The meeting location is:

- Department of Consumer Affairs
  400 R Street, First Floor Hearing Room
  Sacramento, California.

If you have any additional information you want the Commission to consider for this item, please provide that information to Leslie R. Williams no later than October 27, 2000.

If you have any questions please call me at 323-8785 or Leslie R. Williams at 323-0118.

STATE OF CALIFORNIA - BUSINESS, TRANSPORTATION AND HOUSING AGENCY GRAY DAVIS, GOVERNOR
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
Division of Legal Affairs
1800 Third Street, Suite 440
P.O. Box 952052
Sacramento, CA 94252-2052
(916) 323-7288
FAX (916) 322-2815

October 16, 2000

Stan Nishimura,
Executive Director
California Building Standards Commission
1301 K Street, Suite 101
Sacramento, CA 95814

Re: Submission of Emergency Regulations for the Limited Use of Chlorinated Polyvinyl Chloride (CPVC) Pipe for Potable Water Piping in Residential Buildings

Dear Mr. Nishimura;

The California Department of Housing and Community Development (DHCD) is submitting the attached Emergency Regulation Package in preparation for the November 14, 2000 Building Standards Commission Hearing. The Emergency Regulation Package is for adoption of regulations into Title 24, California Plumbing Code. These regulations are for statewide application and would expand the use of Chlorinated Polyvinyl Chloride (CPVC) pipe as an alternative material in residential buildings. CPVC pipe will be permitted for potable water piping only in those situations where the local building official has made a determination that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions and the installation is in compliance with specific mitigation measures.

DHCD has prepared a Draft Negative Declaration with Mitigation Measures (SCH # 2000091089) for this building standard that will be certified prior to the November 14th Commission meeting. This certified Negative Declaration will satisfy the California Environmental Quality Act requirements of the court order in *Cuffe v. California Building Standards Commission and the Department of Housing and Community Development*.

Enclosed are one Face Sheet and 35 copies of the Finding of Emergency, Express Terms, and Nine-Point Criteria Analysis as required for submission of this Emergency Package to the Building Standards Commission. If you have any questions or comments, please contact me at (916) 323-7288.

Sincerely,

William J. Staack

William J. Staack, Esq., P.E.
Staff Counsel

Enclosures

STATE OF CALIFORNIA
BUILDING STANDARDS COMMISSION

BUILDING STANDARDS NOTICE/SUBMISSION

BSC-FACE SHEET (REV. 04/27/2000) Page 1

Notice Register Number	Publication Date
Notice File Number: Z-	

RECEIVED
OCT 16 2000
BUILDING STANDARDS COMMISSION

Building Standards Commission

State Agency	Submittal #	Item #

Office of Administrative Law

Secretary of State

APPLICANTS – DO NOT USE THE ABOVE SPACE

1. PROPOSING AGENCY DIRECTOR OR DESIGNEE (Attach delegation order of designee)
Julie Bornstein, Director

STATE AGENCY				TELEPHONE NUMBER
Department of Housing and Community Development				(916) 323-7288
STREET ADDRESS	CITY	STATE	ZIP CODE	FAX NUMBER
1800 3rd street, Suite 440	Sacramento	CA	95814	(916) 323-2815

2. SUBMITTAL – SUGGESTED REVISIONS TO THE CALIFORNIA CODE OF REGULATIONS, TITLE 24
SUBJECT: Limited Use of CPVC Pipe in Residential Buildings
AGENCY FILE NUMBER:

3. NATURE OF PROCEEDINGS (GC §11346.5(a)(1))

PARTS/SECTIONS AFFECTED

Adopt CA RegulationsTitle 24, part 5, Section 604.1b and Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, Section 301.0

4. TYPE OF FILING

☐ Notice of Proposed Action ☐ Regular Rulemaking ☐ Resubmittal ☒ Emergency ☐ Other (Specify)

☒ Certification of Compliance: The agency officer named below certifies that this agency complies with the provisions of Government Code §§ 11346.6 – 11346.8 prior to, or within 120 days of, the effective date of the regulations contained in this filing.

☐ Changes without regulatory effect (Attach explanation and justification analysis supporting that the proposed change(s) does not materially alter any rights, responsibilities, conditions, prescription or other regulatory element of any California Code of Regulations provisions.

5. EFFECTIVE DATE OF REGULATORY CHANGE

☐ Effective 180 days after publication in the California Building Standards Code ☐ Effective 30th day after filing with the Secretary of State ☒ Effective on filing with Secretary of State ☐ Effective other (Specify)

6. AUTHORITY – Specify Statute(s) or Law(s) Authorizing the adoption(s) (GC §11346.2(a)(2) & §11346.5(2)):
Sections 18949.5, 17921 and 17922 of the Health and Safety Code

7. REFERENCE – Provisions of law being implemented, interpreted or made specific by the regulations:
Section 17921 and 17922 of the Health and Safety Code

8. NAME AND TELEPHONE NUMBER OF THE AGENCY OFFICER TO WHOM INQUIRIES CONCERNING THE PROPOSED ACTION MAY BE DIRECTED
Bill Staack, Staff Counsel (916) 323-7288

CERTIFICATION— IMPORTANT– PLEASE READ BEFORE SIGNING– If not signed, this application may be rejected.

I certify that the attached copy of regulation(s) is a true and correct copy of the regulation(s) identified in this filing, that the information specified in this filing is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to makes this certification. I further understand that any false, incomplete, or incorrect statements may result in the rejections of this filing.

AGENCY DIRECTOR OR DESIGNEE SIGNATURE	DATE SIGNED
[illegible]	10/10/2000
TYPE NAME AND TITLE OF SIGNATORY: Julie Bornstein, Director	

RECEIVED

OCT 16 2000

BUILDING STANDARDS COMMISSION

FINDING OF EMERGENCY
OF THE
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

EMERGENCY FINDING:

Pursuant to Section 11346.1 of the Government Code, the Department of Housing and Community Development (DHCD) finds that adoption of the enclosed building standard is necessary for the immediate preservation of the public peace, health and safety or general welfare.

Purpose of Proposed Building Standard:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing the homes to be initially installed with, or in the case of failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe. DHCD is proposing to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems." If adopted, the proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings if the official has determined that there is or will be a premature failure of metallic pipe if installed in such residential buildings due to corrosive water and/or soil conditions.

Problem:

Various areas of the state are experiencing premature failure of metallic pipe in residential buildings. Information in the record of previous DHCD examinations of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before DHCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. DHCD has determined that

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BUILDING STANDARDS COMMISSION

NINE-POINT CRITERIA ANALYSIS OF PROPOSED BUILDING STANDARD OF THE CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

Building standards submitted to the California Building Standards Commission for approval are required, by Health and Safety Code Subsection 18930(a), to be accompanied by an analysis which will, to the satisfaction of the Commission, justify their approval. The approval of the proposed building standard is justified as follows:

1) The proposed building standards do not conflict with, overlap, or duplicate other building standards.

Beginning in 1982 section 604.1 of the Uniform Plumbing Code (UPC) published by the International Association of Plumbing and Mechanical Officials (IAPMO) has permitted the use of chlorinated polyvinyl chloride (CPVC) plastic pipe for hot and cold-water distribution within residential buildings. Section 604.1 of the UPC was not adopted by the Department of Housing and Community Development (DHCD) into the California Plumbing Code but was amended by adding section 604.1a to exclude the use of CPVC for water distribution piping in residential buildings pending compliance with CEQA as required by a court order. (*Cuffe v. California Building Standards Commission and the California Department of Housing and Community Development*).

DHCD has now complied with CEQA by certifying a Negative Declaration with Mitigation Measures for the proposed building standard to the California Plumbing Code. The proposed building standard will permit the limited use of CPVC piping for hot and cold-water distribution within residential buildings upon the finding by the local building official that there is or will be the premature failure of metallic pipe and by compliance with all of the proposed mitigation measures.

Given the fact that since 1982 the UPC has allowed the use of CPVC piping for water distribution systems within residential buildings but its use was not adopted by DHCD in the California Plumbing Code pending CEQA compliance, DHCD has made the determination that the proposed building standard for the California Plumbing Code that now adopts the limited use of CPVC piping would not conflict with, overlap, or duplicate other state building standards.

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BUILDING STANDARDS COMMISSION

.C AND FISCAL IMPACT STATEMENT
ATIONS AND ORDERS)

99 (REV. 2-98)

See SAM Sections 6000—6680 for Instructions and Code Citations

DEPARTMENT NAME	CONTACT PERSON	TELEPHONE NUMBER
Housing and Community Development	Bill Staack	(916) 323-72[illegible]
DESCRIPTIVE TITLE FROM *NOTICE REGISTER* OR FORM 400		NOTICE FILE NUMBER
California Plumbing Code (CPVC)		

ECONOMIC IMPACT STATEMENT

A. ESTIMATED PRIVATE SECTOR COST IMPACTS *(Include calculations and assumptions in the rulemaking record.)*

1. Check the appropriate box(es) below to indicate whether this regulation:

[ ] a. Impacts businesses and/or employees

[ ] b. Impacts small businesses

[ ] c. Impacts jobs or occupations

[ ] d. Impacts California competitiveness

[ ] e. Imposes reporting requirements

[ ] f. Imposes prescriptive instead of performance standards

[ ] g. Impacts individuals

[ ] h. None of the above *(Explain below. Complete the Fiscal Impact Statement as appropriate.)*

h. *(cont.)* _____

(If any box in Items 1.a. through g. is checked, complete this Economic Impact Statement.)

2. Enter the total number of businesses impacted: _____ Describe the types of businesses *(Include nonprofits)*: _____

Enter the number or percentage of total businesses impacted that are small businesses: _____

3. Enter the number of businesses that will be created: _____ eliminated: _____

Explain: _____

4. Indicate the geographic extent of impacts: [ ] Statewide [ ] Local or Regional *(list areas)*: _____

5. Enter the number of jobs created: _____ or eliminated _____ Describe the types of jobs or occupations impacted: _____

6. Will the regulation affect the ability of California businesses to compete with other states by making it more costly to produce goods or services he-

[ ] Yes [ ] No If yes, explain briefly: _____

B. ESTIMATED COSTS *(Include calculations and assumptions in the rulemaking record).*

1. What are the total statewide costs that businesses and individuals may incur to comply with this regulation over its lifetime? $ _____

a. Initial costs for a small business: $ _____ Annual ongoing costs: $ _____ Years: _____

b. Initial costs for a typical business: $ _____ Annual ongoing costs: $ _____ Years: _____

c. Initial costs for an individual: $ _____ Annual ongoing costs: $ _____ Years: _____

d. Describe other economic costs that may occur: _____

FINDING OF EMERGENCY
OF THE
DEPARTMENT OF HOUSING & COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

EMERGENCY FINDING:

Pursuant to Section 11346.1 of the Government Code, the Department of Housing and Community Development (DHCD) finds that adoption of the enclosed building standard is necessary for the immediate preservation of the public peace, health and safety or general welfare.

Purpose of Proposed Building Standard:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing the homes to be initially installed with, or in the case of failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe. DHCD is proposing to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems." If adopted, the proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings if the official has determined that there is or will be a premature failure of metallic pipe if installed in such residential buildings due to corrosive water and/or soil conditions.

Problem:

Various areas of the state are experiencing premature failure of metallic pipe in residential buildings. Information in the record of previous DHCD examinations of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before DHCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. DHCD has determined that

at least 16 different counties in California, from southern to northern California, have areas where there are corrosive water and/or soil conditions that have cause premature failure of the existing metallic pipe in residential homes. These premature failures have resulted in loss of residential water service and have caused water damage to the structures. Furthermore, the record indicates that when the metallic pipe fails it contaminates the drinking water with metals that may pose a potential health hazard to homeowners who drink the water and may result in metal contamination of the receiving waters from the drinking water.

For the areas of San Diego, Los Angeles, Riverside, and San Bernardino Counties, the projected life span of a copper pipe in areas of corrosive water was estimated to be one to four years for homes built between 1991 through 1994 and four to eight years overall. Re-piping was conducted in several communities in Southern California, including Del Mar, Poway, La Jolla, Escondido, Carlsbad, and Chula Vista. In these areas, the life of the original copper pipes were found to be three to five years, whereas the re-pipes lasted over 10 years. Extensive re-piping work was also performed in the areas of Santa Clarita and Ventura. The pipes and replacement pipes lasted only two years under these conditions.

The costs associated with re-piping where there is metallic pipe corrosion vary depending on the circumstances and the amount, if any, of water damage. Such corrosion always presents a financial hardship to the homeowners because such costs are not typically anticipated so early in the life of the home. Such hardship is compounded if the replacement occurs multiple times during the life of the home.

DHCD has determined that the best way to resolve the problem of metallic pipe corrosion is to use a piping material that is not affected by corrosion. DHCD has determined that CPVC pipe is an effective alternate building material in those affected areas because the CPVC material is not susceptible to corrosive failure. However, a problem exists for the new or existing homeowner with potential corrosion problems because the current California Plumbing Code does not allow the use of CPVC pipe within residential buildings, only metallic pipe can be used. As a result, homeowners who have problems with corroding metallic pipe are forced to re-pipe their homes every 2 to 10 years similar metallic pipe.

The California legislature temporarily addressed the issue of premature failure of metallic pipe in October 1995, when AB 151 (Stats. 1995. c. 785) was signed into law that allowed the use of CPVC plastic pipe as an alternate building material in residential buildings. This law authorized local governments to permit CPVC piping if the specified statutory conditions were met. This law became inoperative after January 1, 1998 and is no longer available for local governments to approve the use of CPVC piping as an alternative to premature failed metallic pipe.

Resolution of Problem:

DHCD determined that CPVC pipe is an effective alternate building material in those areas of the state with corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure. Pursuant to the court order and settlement agreement discussed below, DHCD has developed the proposed building standard allowing the limited use of CPVC in residential buildings with a Negative Declaration with Mitigation Measures. The findings of the Negative Declaration were that given the limited scope of the proposed project, and/or provided the proposed mitigation measures were complied with, the implementation of the building standard would not result in any significant environmental impacts or potential health hazards to the homeowner or installers of the CPVC pipe.

The building standard would allow the limited use of CPVC pipe in residential buildings upon a finding by the local building official that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions. The proposed building standard is subject to specific conditions and requires that the proposed mitigation measures be implemented. DHCD will also issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. Furthermore, DHCD will provide for periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Necessity for Emergency Adoption of Proposed Building Standard:

DHCD has determined that it is necessary for the emergency approval of the building standard because the clock is ticking for those homeowners in the state that will be facing the need to re-pipe in the next 6 months because of the premature failure of metallic pipe in their homes. It is unknown as to how many homeowners will need to re-pipe within the next 6 months, but with out approval of these emergency regulations these homeowners will face a range of costs that will undoubtedly present a financial hardship to them, as the cost was not anticipated when the house was purchased. These homeowners will not have the option to use CPVC pipe, and will be forced to replace the failed metallic pipe with similar metallic pipe that is susceptible to the same corrosive problems that caused the premature failure to occur. This will also cause the homeowner unnecessary exposure to potential health problems associated with corroded metals in their drinking water. Furthermore, without the emergency approval, any new homes built within the next 6 months in areas with corrosive water and/or soil conditions will be forced to use metallic pipe, which would likely need replacement in a few years if premature failure occurs. Besides the potential health hazards associated with the metal contaminated water, the receiving

waters will continue to be contaminated with the metal contaminated drinking water.

It is necessary to implement this building standard as quickly as possible to inform local agencies of their option to use the corrosive resistant CPVC piping and to inform the business community of the availability of the CPVC alternative piping prior to new construction and re-piping of existing homes in those areas with corrosive water and/or soil conditions.

AUTHORITY AND REFERENCE

The California Building Standards Commission proposes to adopt these building standards under the authority granted by Health and Safety Code Section 18949.5. The purpose of these building standards is to implement, interpret, and make specific the provisions of Health and Safety Code Sections 17921 and 17922 of the State Housing Law. The Department of Housing and Community Development is proposing this regulatory action based on Health and Safety Code Sections 17921 and 17922.

INFORMATIVE DIGEST

Summary of Existing Laws:

The Department of Housing and Community Development (DHCD) has been directed by the Legislature to propose for adoption in the California Plumbing Code, substantially as published, uniform industry codes, including the Uniform Plumbing Code (UPC) published by the International Association of Plumbing and Mechanical Officials (IAPMO) (Health and Safety Code sec. 17922(a)). Beginning with the 1982 edition of the UPC, chlorinated polyvinyl chloride (CPVC) plastic pipe was permitted for use inside residential buildings for hot and cold-water distribution. However, the predecessor to the California Building Standards Commission (CBSC) determined that an Environmental Impact Report (EIR) prepared pursuant to the requirements of the California Environmental Quality Act (CEQA) was needed before approving this expanded use of CPVC plastic pipe in the California Building Code. As part of the adoption of the 1982 UPC, DHCD proposed and the CBSC adopted California Plumbing Code section 604.1a, which prohibits the use of CPVC for hot and cold-water distribution within residential buildings in California pending compliance with CEQA. Section 604.1a has remained a part of the California Plumbing Code ever since, even though each successive edition of the UPC has permitted this use of CPVC. The rationale for the continuing prohibition in the California Plumbing Code was the delayed completion of the EIR.

In October 1995, AB 151 (Stats. 1995. c. 785) was signed into law and allowed the use of CPVC plastic pipe as an alternate building material in residential buildings under specified conditions. DHCD subsequently filed and the CBSC subsequently approved emergency regulations, which had the effect of permitting the use of CPVC plastic pipe for hot and cold-water distribution inside buildings on a statewide basis. This action was successfully challenged in court on the ground that the decision to allow the expanded use of CPVC plastic pipe was a discretionary action subject to the requirements of CEQA (*Cuffe v. California Building Standards Commission and the California Department of Housing and Community Development*). In compliance with the court's order, DHCD performed a preliminary environmental assessment and determined that it would be prudent to prepare a full environmental impact report. DHCD completed and certified an EIR (The Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings; State Clearinghouse Number 90820040; prepared by the Department of Housing & Community Development and certified December 1, 1998, hereinafter referred to as the "CPVC EIR"). The CPVC EIR concluded that permitting the use of CPVC plastic pipe for statewide use for hot and cold-water distribution within residential buildings would not result in any significant environmental impacts.

A court challenge to the 1998 certified CPVC EIR resulted in a settlement agreement to allow the limited use of CPVC pipe in residential buildings. This regulatory proposal and a November 2000 Certified Negative Declaration with Mitigation Measures have been prepared pursuant to this settlement agreement. The Certified Negative Declaration satisfies the CEQA requirement of the court in *Cuffe*. The finding of the Negative Declaration for the proposed building standard was that given the limited scope of the project, and/or provided the proposed mitigation measures were complied with, the implementation of the building standard would not result in any significant environmental impacts or potential health hazards to the homeowner or installer of the CPVC pipe. The settlement agreement provides for rescission of the 1998 certified CPVC EIR and withdrawal of the previous proposed building standard approving CPVC use on a statewide basis. The settlement agreement would allow a building standard for the limited use of CPVC pipe in residential buildings upon a finding by the local building official that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions. The settlement agreement required specific conditions and mitigation measures to be included in the building standard and also provides that DHCD issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. Furthermore, the settlement agreement also provides for DHCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Summary of Existing Regulations:

The Uniform Plumbing Code section 604.1 permits this use of CPVC plastic pipe in residential buildings; however, DHCD did not adopt section 604.1. DHCD adopted an amendment, section 604.1a into the California Plumbing Code, Title 24, Chapter 6, that does not permit the use of CPVC plastic pipe for purposes of hot and cold-water distribution within residential buildings (HCD 1 and HCD 2 occupancies).

Summary of Effect:

The proposed action is to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems." These new sections incorporate specific mitigation measures that are necessary to comply with the CEQA requirements for the November 2000 certified Negative Declaration with Mitigation Measures.

If adopted, the proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings subject to specified conditions and mitigation measures that are incorporated into the regulatory proposal. A local building official would be authorized to approve the use of CPVC only if he or she first determines that there is or will be a premature failure of metallic pipe if installed in such residential buildings due to corrosive water and/or soil conditions. Any building permit issued by the local building official authorizing the use of CPVC based on such a finding would be conditioned on compliance with the specific mitigation measures in the building standard.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the potential scope of CPVC use that will result from the proposed building standard will be limited. Information in the record of previous HCD examinations of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before DHCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the DHCD has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

Comparable Federal Statute or Regulations:

CPVC pipe is approved for use in manufactured home hot and cold-water systems through the federal National Manufactured Housing Construction and Safety Standards Act of 1974 (this Act preempts state regulations of manufactured housing construction standards).

Small Business Affect:

As discussed above in the "Summary of Effect," the potential scope of CPVC use that will result from the proposed building standard should be limited because the information in the record indicates that metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence before DHCD indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. DHCD has made a determination that CPVC pipe is an effective alternative building material in those areas of the state with corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure. For these reasons, the DHCD has concluded that CPVC pipe is an acceptable alternative for premature failed metallic pipe, but that the resulting installation of CPVC pipe in California from the proposed regulatory approval will be limited in scope.

To the extent that CPVC plastic pipe is authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, there could be some reduction in the business of California metallic pipe manufacturers, distributors, and retailers. However, these potential losses would be offset by gains in the business of CPVC plastic pipe manufacture, distribution and retailing. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduced the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the DHCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

Plain English Policy Statement:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed

prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing the homes to be initially installed with, or in the case of failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe.

The proposed building standard regarding the California Plumbing Code, Part 5 of Title 24 of the California Code of Regulations (CCR) will alleviate unnecessary financial hardships caused by premature failure of metallic pipe in residential buildings. Specifically, they will permit the limited use of CPVC pipe in residential building where it is determined by a local building official that there is or will be the premature failure of metallic pipe and the pipe is installed pursuant to specified mitigation measures.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the potential scope of CPVC use that will result from the proposed building standard will be limited. Information in the record of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before the Department of Housing and Community Development (DHCD) indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the DHCD has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

The proposed building standard contains the following conditions:

1. A local building official would be authorized to approve the use of CPVC only if that official determines that there is or will be a premature failure of metallic pipe.
2. Any building permit issued by the local building official authorizing the use of CPVC would be conditioned on compliance with specific measures described in the regulations.
3. Only approved CPVC plumbing piping could be used.
4. Installations and uses of CPVC would be required to comply with all applicable requirements of the California Plumbing Code.
5. Prior to issuing a building permit authorizing use of CPVC, the contractor must provide certain written certifications.
6. Final permit approval cannot be given unless the material has been installed in compliance with the requirements of the California Plumbing Code.

7. A contractor not installing CPVC correctly would be subject to penalties.

MATTERS PRESCRIBED BY STATUTE APPLICABLE TO THE AGENCY OR TO ANY SPECIFIC REGULATION OR CLASS OF REGULATIONS

California Environmental Quality Act (CEQA): Title 25, California Code of Regulations, section 6971(b)(1) requires the DHCD to make an initial assessment whether an activity my have a significant effect on the environment. As discussed above, CEQA compliance was also required as a result of a court challenge to the use of CPVC pipe in residential buildings (*Cuffe v. California Building Standards Commission and the California Department of Housing and Community Development*). In November 2000, DHCD certified a Negative Declaration with Mitigation Measures for the proposed building standard. The certified Negative Declaration concludes that the proposed building standard, which permits the limited use of CPVC plastic pipe for hot and cold-water distribution within residential buildings, would not result in any significant environmental impacts if all the mitigation measures were implemented.

MANDATE ON LOCAL AGENCIES OR SCHOOL DISTRICTS

The Department of Housing and Community Development has determined that the proposed regulatory action would not impose a mandate on local agencies or school districts, therefore does not mandate state reimbursement pursuant to Part 7 (commencing with Section 17500) of Division 4 of the Government Code.)

FISCAL IMPACT STATEMENT(attached Form 399)

A. Cost or Savings to any state agency: **NO**
B. Cost to any local agency required to be reimbursed under Part 7(commencing with Section 17500) of Division 4: **NO**
C. Cost to any school district required to be reimbursed under Part 7 (commencing with Section 17500) of Division 4: **NO**
D. Other nondiscretionary cost or savings imposed on local agencies: **NO**
E. Cost or savings in federal funding to the state: **No**

Estimate: [Insert estimate of cost or savings for A through E]

STATE OF CALIFORNIA

ECONOMIC AND FISCAL IMPACT STATEMENT

(REGULATIONS AND ORDERS)

S 99 (REV. 2-98) *See SAM Sections 6000—6680 for Instructions and Code Citations*

DEPARTMENT NAME	CONTACT PERSON	TELEPHONE NUMBER
Housing and Community Development	Bill Staack	(916) 323-72E
DESCRIPTIVE TITLE FROM *NOTICE REGISTER* OR FORM 400		NOTICE FILE NUMBER
California Plumbing Code (CPVC)		

ECONOMIC IMPACT STATEMENT

A. ESTIMATED PRIVATE SECTOR COST IMPACTS *(Include calculations and assumptions in the rulemaking record.)*

1. Check the appropriate box(es) below to indicate whether this regulation:

[ ] a. Impacts businesses and/or employees

[ ] b. Impacts small businesses

[ ] c. Impacts jobs or occupations

[ ] d. Impacts California competitiveness

[ ] e. Imposes reporting requirements

[ ] f. Imposes prescriptive instead of performance standards

[ ] g. Impacts individuals

[ ] h. None of the above *(Explain below. Complete the Fiscal Impact Statement as appropriate.)*

h. *(cont.)* _____

(If any box in Items 1.a. through g. is checked, complete this Economic Impact Statement.)

2. Enter the total number of businesses impacted: _____ Describe the types of businesses *(Include nonprofits)*: _____

Er 'he number or percentage of total businesses impacted that are small businesses: _____

3. Enter the number of businesses that will be created: _____ eliminated: _____

Explain: _____

4. Indicate the geographic extent of impacts: [ ] Statewide [ ] Local or Regional *(list areas)*: _____

5. Enter the number of jobs created: _____ or eliminated _____ Describe the types of jobs or occupations impacted: _____

6. Will the regulation affect the ability of California businesses to compete with other states by making it more costly to produce goods or services here

[ ] Yes [ ] No If yes, explain briefly: _____

B. ESTIMATED COSTS *(Include calculations and assumptions in the rulemaking record).*

1. What are the total statewide costs that businesses and individuals may incur to comply with this regulation over its lifetime? $ _____

a. Initial costs for a small business: $ _____ Annual ongoing costs: $ _____ Years: _____

b. Initial costs for a typical business: $ _____ Annual ongoing costs: $ _____ Years: _____

c. Initial costs for an individual: $ _____ Annual ongoing costs: $ _____ Years: _____

d. Describe other economic costs that may occur: _____

E. MAJOR REGULATIONS *(Include calculations and assumptions in the rulemaking record.)*
Cal/EPA boards, offices and departments are subject to the following additional requirements per Health and Safety Code section 57005.

1. Will the estimated costs of this regulation to California business enterprises exceed $10 million? [ ] Yes [ ] No *(If No, skip the rest of this section)*

2. Briefly describe each equally as effective alternative, or combination of alternatives, for which a cost-effectiveness analysis was performed:

Alternative 1: _____

Alternative 2: _____

5. For the regulation, and each alternative just described, enter the estimated total cost and overall cost-effectiveness ratio:

Regulation: $ _____ Cost-effectiveness ratio: _____

Alternative 1: $ _____ Cost-effectiveness ratio: _____

Alternative 2: $ _____ Cost-effectiveness ratio: _____

FISCAL IMPACT STATEMENT

A. FISCAL EFFECT ON LOCAL GOVERNMENT *(Indicate appropriate boxes 1 through 6 and attach calculations and assumptions of fiscal impact for the current year and two subsequent Fiscal Years)*

[ ] 1. Additional expenditures of approximately $_____ in the current State Fiscal Year which are reimbursable by the State pursuant to Section 6 of Article XIII B of the California Constitution and Sections 17500 et seq. of the Government Code. Funding for this reimbursement:

[ ] a. is provided in (Item _____, Budget Act of _____) or (Chapter _____, Statutes of _____)

[ ] b. will be requested in the _____ (FISCAL YEAR) Governor's Budget for appropriation in Budget Act of _____

[ ] 2. Additional expenditures of approximately $_____ in the current State Fiscal Year which are not reimbursable by the State pursuant to Section 6 of Article XIII B of the California Constitution and Sections 17500 et seq. of the Government Code because this regulation:

[ ] a. implements the Federal mandate contained in _____

[ ] b. implements the court mandate set forth by the _____ court in the case of _____ vs. _____

[ ] c. implements a mandate of the people of this State expressed in their approval of Proposition No. _____ at the _____ (date) election;

[ ] d. is issued only in response to a specific request from the _____ which is/are the only local entity(s) affected:

[ ] e. will be fully financed from the _____ (FEES, REVENUE, ETC) authorized by Section _____ of the _____ Code;

[ ] f. provides for savings to each affected unit of local government which will, at a minimum, offset any additional costs to each such unit.

[ ] 3. Savings of approximately $ _____ annually.

[ ] 4. No additional costs or savings because this regulation makes only technical, non-substantive or clarifying changes to current law and regulations.

[ ] 5. No fiscal impact exists because this regulation does not affect any local entity or program.

[X] 6. Other. Minimal costs to local governments in affected areas. The proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings

B. FISCAL EFFECT ON STATE GOVERNMENT *(Indicate appropriate boxes 1 through 4 and attach calculations and assumptions of fisc impact for the current year and two subsequent Fiscal Years.)*

[ ] 1. Additional expenditures of approximately $ _____ in the current State Fiscal Year. It is anticipated that State agencies wil

[ ] a. be able to absorb these additional costs within their existing budgets and resources.

[ ] b. request an increase in the currently authorized budget level for the _____ fiscal year.

[ ] 2. Savings of approximately $ _____ in the current State Fiscal Year.

[ ] 3. No fiscal impact exists because this regulation does not affect any State agency or program.

[X] 4. Other HCD will provide for periodic monitoring of the local implementation of the mitigation measures required for CPVC use. Costs will be absorbed throu normal business operations.

C. FISCAL EFFECT ON FEDERAL FUNDING OF STATE PROGRAMS *(Indicate appropriate boxes 1 through 4 and attach calculations and assumptio of fiscal impact for the current year and two subsequent Fiscal Years.)*

[ ] 1. Additional expenditures of approximately $ _____ in the current State Fiscal Year.

[ ] 2. Savings of approximately $ _____ in the current State Fiscal Year.

[X] 3. No fiscal impact exists because this regulation does not affect any federally funded State agency or program.

[ ] 4. Other _____

SIGNATURE Gail Neuis for Julie Bornstein		TITLE DIRECTOR
AGENCY SECRETARY[1] APPROVAL/CONCURRENCE		DATE
DEPARTMENT OF FINANCE[2] APPROVAL/CONCURRENCE	PROGRAM BUDGET MANAGER	DATE

1. *The signature attests that the agency has completed the STD. 399 according to the instructions in SAM sections 6600-6680, and understands the impacts of the proposed rulemaking. State boards, offices, or departments not under an Agency Secretary must have the form signed by the highe ranking official in the organization.*

2. *Finance approval and signature is required when SAM sections 6600-6670 require completion of the Fiscal Impact Statement in the STD. 399. However, Finance must immediately receive a copy of each STD. 399 submitted to OAL without Finance signature, and Finance may subsequently question the no fiscal impact finding of a state agency.*

EXPRESS TERMS
OF
PROPOSED BUILDING STANDARDS
OF THE
CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE, CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

(Draft the regulations in plain, straightfoward language, avoiding technical terms as much as possible. If not feasible to draft the regulation in plain English due to the technical nature of the regulation, the agency shall prepare a noncontrolling plain English summary of the regulations. Notation following the express terms of each regulation listing the specific statutes authorizing the adoption and listing specific statutes being implemented, interpreted, or made specific. (PART 1 – ADMINISTRATIVE CODE) Underline to indicate additions, strikeout to indicate deletions, italics to indicate California regulations, and normal type to indicate model code.)

NON-CONTROLLING PLAIN ENGLISH SUMMARY STATEMENT:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing homes to be initially installed with, or in the case of a failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe.

The proposed building standard regarding the California Plumbing Code, Part 5 of Title 24 of the California Code of Regulations (CCR) will alleviate unnecessary financial hardships caused by premature failure of metallic pipe in residential buildings. Specifically, it will permit the limited use of CPVC pipe in residential building where a local building official has determined that there is or will be a premature failure of metallic pipe and provided that the pipe is installed pursuant to specified mitigation measures.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the Department of Housing and Community Development (DHCD) anticipates that the potential scope of CPVC use that will result from the proposed project will be limited. Information in the record of CPVC pipe indicates that problems with corrosive water and/or soils conditions exist throughout California, but is not a widespread problem. The evidence before DHCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the DHCD has concluded that the CPVC installations that may result from the proposed regulatory approval should be limited in scope.

The proposed building standard contain the following conditions:

1. A local building official would be authorized to approve the use of CPVC only if that official determines that there is or will be a premature failure of metallic pipe due to water and/or soil conditions.
2. Any building permit issued by the local building official authorizing the use of CPVC would be conditioned on compliance with specific measures described in the regulations.
3. Only approved CPVC plumbing piping could be used.
4. Installation and use of CPVC would have to comply with all applicable requirements of the California Plumbing Code.
5. Prior to issuing a building permit authorizing use of CPVC, the contractor must provide certain written certifications.
6. Final permit approval cannot be given unless the material has been installed in compliance with the requirements of the California Plumbing Code.
7. A contractor not installing CPVC correctly would be subject to penalties.

EXPRESS TERMS:

Section 604.0 Materials
Section 604.1 Water pipe and fittings shall be of brass, copper, cast iron, galvanized malleable iron, galvanized wrought iron, galvanized steel, or other approved materials. Cast iron fittings used for water need not be galvanized if over two (2) inches (51 mm) in size. Asbestos-cement, CPVC, PE, or PVC water pipe manufactured to recognized standards may be used for cold water distribution systems outside a building. CPVC water pipe and tubing may be used for hot and cold-water distributions systems within a building. All materials used in the water supply system, except valves and similar devices shall be of a like material, except where otherwise approved by the Administrative Authority.

Section 604.1a [HCD 1 & 2] Water pipe and fittings shall be of brass, copper, cast iron, galvanized malleable iron, galvanized wrought iron, galvanized steel, or other approved materials. Cast iron fittings used for water need not be galvanized if over two (2) inches (51 mm) in size. Asbestos-cement, CPVC, PE, or PVC water pipe manufactured to recognized standards may be used for cold water distribution systems outside a building. All materials used in the water supply system, except valves and similar devices shall be of a like material, except where otherwise approved by the Administrative Authority.

Section 604.1b[HCD 1&2] Local Authority to Approve CPVC Pipe Within Residential Buildings Under Specified Conditions.
The local responsible building official of any city or county, in accordance with the procedures set forth in Chapter 3 (with the exception of section 301.2.7) may authorize

by permit the use of CPVC for hot and cold-water distribution systems within the interior of residential buildings provided all of the following conditions are satisfied:

*(a) **Finding Required.** The building official shall first make a determination that there is or will be the premature failure of metallic pipe if installed in such residential buildings due to existing water or soil conditions.*

*(b) **Permit Conditions.** Any building permit issued pursuant to this section shall be conditioned on compliance with the mitigation measures set forth in this section.*

*(c) **Approved Materials.** Only CPVC plumbing material listed as an approved material in, and installed in accordance with this code may be used.*

*(d) **Installation and Use.** Any installation and use of CPVC plumbing material pursuant to this section shall comply with all applicable requirements of this code and Section 301.0 of Appendix I of this code, Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distributions Systems, IAPMO IS 20-96.*

*(e) **Certification of Compliance.** Prior to issuing a building permit pursuant to this section, the building official shall require as part of the permitting process that the contractor, or the appropriate plumbing subcontractors, provide written certification: (1) that is required in subdivision (f); and (2) that he or she will comply with the flushing procedures and worker safety measures set forth in Section 301.0 of Appendix I of this code, Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems IAPMO IS 20-96.*

*(f) **Worker Safety.** Any contractor applying for a building permit that includes the use of CPVC plumbing materials authorized pursuant to this section shall include in the permit application a signed written certification stating that:*

(1) They are aware of the health and safety hazards associated with CPVC plumbing installations.

(2) They have included in their Illness and Injury Prevention Plan the hazards associated with CPVC plumbing pipe installations; and

(3) The worker safety training elements of their Injury and Illness Prevention Plan meets the Department of Industrial Relation's guidelines.

*(g) **Findings of Compliance.** The building official shall not give final permit approval of any CPVC plumbing materials installed pursuant to this section unless he or she finds that the material has been installed in compliance with the requirements of this code and that the installer has complied with the requirements in section 301.0.1, of Appendix I of this code, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, IAPMO IS 20-96.*

*(h) **Penalties.** Any contractor or subcontractor found to have failed to comply with the ventilation, glove or flushing requirements of section 301.0 of Appendix I of this code, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, IAPMO IS 20-96 shall be subject to the penalties in Health and Safety Code, division 13, part 1.5, chapter 6 (section 17995 et seq). In addition, if during the conduct of any building inspection the building official finds that the ventilation and glove requirements of section 301.0 of Appendix I of this code, Special Requirements for CPVC Installation within Residential Buildings, are being violated, such building officials shall cite the contractor or subcontractor for that*

violation.

Note: [For HCD 1 & 2] *CPVC installations shall be subject to the work practices established in the California Health and Safety Code, Division 13, Part 1.5, Section 17291.9.*

Section 301.0 Special Requirements for CPVC Installation Within Residential Buildings Only. [HCD 1]

In addition to the other requirements in the California Plumbing Code and this Appendix for the Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distributions Systems, all installations of CPVC pipe within residential structures shall meet the following.

301.0.1 Flushing Procedures.

301.0.1.1 All installations of CPVC pipe within residential structures shall be flushed twice over a period of at least one week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. At the time of the fill, each fixture shall have a removable tag applied stating:

"This new plumbing system was first filled on (date) by (name). The California Department of Housing and Community Development requires that the system be flushed after standing at least one week after the fill date specified above. If the system is used earlier than one week after the fill date, the water must be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to flushing, except by the homeowner."

301.0.2 Worker Safety Measures.

301.0.2.1 Mechanical ventilation sufficient to maintain exposures below the relevant exposure limits established by state regulations shall be provided in enclosed spaces. This ventilation shall be directed at the breathing zone of the worker installing the pipe. Where mechanical ventilation is not practical, respirators, suitable for organic vapors, shall be used. For the purpose of this subdivision, and enclosed space is defined as:

(a) A space less than 100 square feet of floor area under a ceiling with a height of 10 feet or less, and which does not have openings (consisting of doors, windows, or unfinished walls) on at least two sides;

(b) Crawl spaces having a height of less than three feet;
(c) Enclosed attics that have a roof and ceiling; or
(e) Trenches having a depth greater than twenty-four inches.

3.01.0.2.2 Installers of CPVC pipe within residential structures shall use non-latex thin gauge (4 millimeters) nitrile gloves, or other gloves providing an equivalent or better degree of protection during the installation of the CPVC plumbing system. Gloves shall be provided to all workers by the contractor, or plumbing subcontractor, and shall be replaced upon contamination by cements.

Section 301.1 Minimal Standards

3011.1. Materials shall comply with the following . . .
Primer 1 - Listed primers shall be used . . .
301.1.2.3 Solvent Cement . . .
301.1.2.4.1 Primer . . .

Section 316.1 Solvent Cement Joints

316.1.1 Safety Requirements and Precautions (*FN from Appendix of XI ASTM 2564-88*)

(b) Use of ventilating devices.
(c) Proper eye protection
(g) Proper gloves impervious to and unaffected by . . .

316.1.1.1 Selection. Follow manufacture recommendations
316.1.1.3 Primer Listed primer in compliance with ASTM F 656-93

609.0 Installation, Inspection and Testing

- Location Prohibition
- Water Heater distance limitation
- Identification
- Testing - no air testing allowed.

NINE-POINT CRITERIA ANALYSIS
OF
PROPOSED BUILDING STANDARD
OF THE
CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

Building standards submitted to the California Building Standards Commission for approval are required, by Health and Safety Code Subsection 18930(a), to be accompanied by an analysis which will, to the satisfaction of the Commission, justify their approval. The approval of the proposed building standard is justified as follows:

1) The proposed building standards do not conflict with, overlap, or duplicate other building standards.

Beginning in 1982 section 604.1 of the Uniform Plumbing Code (UPC) published by the International Association of Plumbing and Mechanical Officials (IAPMO) has permitted the use of chlorinated polyvinyl chloride (CPVC) plastic pipe for hot and cold-water distribution within residential buildings. Section 604.1 of the UPC was not adopted by the Department of Housing and Community Development (DHCD) into the California Plumbing Code but was amended by adding section 604.1a to exclude the use of CPVC for water distribution piping in residential buildings pending compliance with CEQA as required by a court order. (*Cuffe v. California Building Standards Commission and the California Department of Housing and Community Development*).

DHCD has now complied with CEQA by certifying a Negative Declaration with Mitigation Measures for the proposed building standard to the California Plumbing Code. The proposed building standard will permit the limited use of CPVC piping for hot and cold-water distribution within residential buildings upon the finding by the local building official that there is or will be the premature failure of metallic pipe and by compliance with all of the proposed mitigation measures.

Given the fact that since 1982 the UPC has allowed the use of CPVC piping for water distribution systems within residential buildings but its use was not adopted by DHCD in the California Plumbing Code pending CEQA compliance, DHCD has made the determination that the proposed building standard for the California Plumbing Code that now adopts the limited use of CPVC piping would not conflict with, overlap, or duplicate other state building standards.

2) The proposed building standards are within the parameters established by enabling legislation, and are not expressly within the exclusive jurisdiction of another agency.

California state law, Health and Safety Code Division 13, Part 1.5, section 17922, subdivision (a)(3) authorizes DHCD to propose for adoption a California Plumbing Code which imposes substantially the same requirements as the most recent edition of the UPC published by IAPMO. As discussed in criteria number 1 above, Section 604.1 of the UPC, which allows the use of CPVC piping in residential buildings, was not adopted by DHCD into the California Plumbing Code but was amended by adding section 604.1a to exclude the use of CPVC for water distribution piping in residential buildings pending a court order to comply with CEQA. DHCD has now complied with CEQA by certifying a Negative Declaration with Mitigation Measures for the proposed building standard to the California Plumbing Code. The proposed buildings standard, would allow the limited use of CPVC pipe in residential buildings, would partially conform to the unadopted section 604.1 found in the most recent edition of the 1997 UPC published by IAPMO, which allows unlimited use of CPVC piping in residential building.

Given the facts that: (1) DHCD has the authority to adopt the UPC into the California Plumbing Code; and (2) the most recent edition of the 1997 UPC allows the unlimited use of CPVC piping for residential buildings and the proposed building standard will allow the limited use of CPVC piping in residential building; DHCD has made the determination that the proposed building standard for the California Plumbing Code is therefore within the parameters established by legislation and not expressly within the exclusive jurisdiction of another agency.

3) The public interest requires the adoption of the building standards.

Currently, various cities in California, such as the City of Colton, are experiencing premature failure of metallic piping used for hot and cold-water systems within residential buildings because of corrosive water and/or soil conditions. The failure of such metallic pipe has resulted in property damage and an unnecessary financial burden on homeowners by requiring such homeowners to continually re-plumb their homes. This premature corrosion also leads to an economic burden for contractors and insurance companies. The record also shows evidence that deteriorating metallic pipe causes metal contamination of the drinking water and can pose potential health hazards to the homeowners and may contribute to environmental degradation to the receiving waters.

Beginning with the 1982 edition of the Uniform Plumbing Code, CPVC was permitted for use inside residential buildings for hot and cold-water distribution. However, as discussed above, the current California Plumbing Code does not allow the use of CPVC as a replacement for the prematurely-failed metallic pipe in residential buildings. As a result, homeowners who have experienced problems with premature failure of metallic pipe have been required to re-pipe their homes every 2 to 10 years with similar corroding metallic pipe.

DHCD has made a determination that CPVC pipe is an effective alternative building material in those areas that have corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure. DHCD has determined that if the proposed building standard is adopted, contractors and homeowners would have the option, not mandate, of using CPVC plastic pipe in place of metallic pipe, if there is a finding by the local building official that there is or would be the premature failure of metallic pipe due to corrosive water and/or soil conditions. The use of CPVC under these circumstances would thereby end the need for the continuous replacement of corroding metallic pipe by homeowners and eliminate the potential health hazards and environmental degradation of the receiving waters that would be associated with metal contamination of the drinking water from corroding pipes.

The CPVC Negative Declaration with Mitigation Measures certified in November 2000 has found that there are no significant environmental impacts associated with the proposed building standard because the potential scope of CPVC use that will result from the standard will be limited and provided the proposed mitigation measures are implemented. The record indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state. The CPVC Negative Declaration also found that the proposed building standard would not pose any significant health risks to pipe installers or homeowners if the proposed mitigation measures are implemented.

Given the facts that: (1) there exists areas in California where homeowners need an alternative to metallic pipe due to corrosive water and/or soil conditions; (2) that CPVC material is not susceptible to corrosive failure; (3) that CPVC has been an approved piping material for water distribution in residential building under the Uniform Plumbing Code since 1982; (4) that the proposed building standard to be adopted into the California Plumbing Code has undergone CEQA review and satisfied the requirements of CEQA ; (5) that the proposed building standard is based on a DHCD certified Negative Declaration with Mitigations Measures and; (6) the proposed building standard is an option for the homeowner and builder and does not mandate the use of CPVC plastic pipe for residential hot and cold water distribution systems; DHCD has determined that it is in the public best interest to adopt the proposed building standard.

4) The proposed building standards are not unreasonable, arbitrary, unfair, or capricious, in whole or in part.

Currently, various cities in California, such as the City of Colton, are experiencing premature failure of metallic piping used for hot and cold-water distribution systems within residential buildings because of corrosive water and/or soil conditions. The failure of such metallic pipe has resulted in property damage and an unnecessary financial burden on homeowners by requiring such homeowners to continually re-plumb their homes. This premature corrosion also leads to an economic burden for contractors and insurance companies. The record also shows evidence that deteriorating metallic pipe causes metal contamination of the drinking water and can pose potential health hazards to the homeowners and may contribute to environmental degradation to the receiving waters.

Beginning with the 1982 edition of the Uniform Plumbing Code, CPVC was permitted for use inside residential buildings for hot and cold-water distribution. However, as discussed above, the current California Plumbing Code does not allow the use of CPVC as a replacement for the prematurely-failed metallic pipe in residential buildings. As a result, homeowners who have experienced problems with premature failure of metallic pipe have been required to re-pipe their homes every 2 to 10 years with similar corroding metallic pipe.

DHCD has made a determination that CPVC pipe is an effective alternative building material in those areas that have corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure. DHCD has determined that if the proposed building standard is adopted, contractors and homeowners would have the option, not mandate, of using CPVC plastic pipe in place of metallic pipe, if the local building official finds that there is or would be the premature failure of metallic pipe due to corrosive water and/or soil conditions. The use of CPVC under these circumstances would thereby end the need for the continuous replacement of corroding metallic pipe by homeowners and eliminate the potential for health hazards and environmental degradation of the receiving waters that would be associated with metal contamination of the drinking water from corroding pipes.

The CPVC Negative Declaration with Mitigation Measures certified in November 2000 has found that there are <u>no</u> significant environmental impacts associated with the proposed building standard because the potential scope of CPVC use that will result from the standard will be limited. The record indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state. The CPVC Negative Declaration also found that the proposed building standard would not pose any significant health risks to pipe installers or homeowners if the proposed mitigation measures are used.

Given the facts that: (1) there exists areas in California where homeowners need an alternative to metallic pipe due to corrosive water and/or soil conditions; (2) that CPVC material is not susceptible to corrosive failure; (3) that CPVC has been an approved piping material for water distribution in residential building in the Uniform Plumbing Code since 1982; (4) that the proposed building standard to be adopted into the California Plumbing Code was pending compliance with CEQA which has now been completed; (5) that the proposed building standard is based on a certified Negative Declaration with Mitigations Measures and; (6) the proposed building standard is an option for the homeowner and builder and does not mandate the use of CPVC plastic pipe for residential hot and cold water distribution; DHCD has made a determination that the proposed building standard is not unreasonable, arbitrary, unfair, or capricious, in whole or in part.

5) The cost to the public is reasonable, based on the overall benefit to be derived from the building standards.

Because the proposed building standard does not mandate the use of CPVC plastic pipe for residential hot and cold-water distribution, the proposed building standard would not impose any additional cost on the public. On the contrary, use of CPVC plastic pipe in areas where corrosive water and/or soil conditions lead to premature failure of metallic pipes could save money by avoiding the ongoing need for costly re-plumbing of failed metallic pipe every few years. The CPVC plastic pipe is not subject to the corrosion problems of the associated metallic pipe. In addition, the CPVC Negative Declaration with Mitigation Measures certified in November 2000 has found that there are <u>no</u> significant environmental impacts associated with the proposed building standard because the potential scope of CPVC use that will result from the standard is expected to be limited. The record indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state. The CPVC Negative Declaration also found that the proposed building standard would not pose any significant health risks to pipe installers or homeowners if the proposed mitigation measures are used. Consequently, DHCD has determined that the cost to the public is reasonable based on the overall benefit to be derived from the amendment by eliminating the need of continuous replacement of failed metallic pipe.

6) The proposed building standards are not unnecessarily ambiguous or vague, in whole or in part.

The proposed buildings standard would incorporate new language modeled after existing language of the UPC published by IAPMO. The language of the UPC is extensively reviewed, edited and developed to avoid ambiguity or vagueness. As with other model codes, the UPC is widely accepted and familiar to nearly

everyone in the building industry. DHCD has independently reviewed the proposed language to be adopted into the California Plumbing Code and has determined that it is not unnecessarily ambiguous or vague, in whole or in part.

7) The applicable national specifications, published standards, and model codes have been incorporated therein as provided in this part, where appropriate. *(Health and Safety Code Section 18938 requires a statement of inadequacy of a national specification, published standard, or model code if it does not adequately address the goals of the state agency, OR a statement informing the Commission that no national specification, published standard, or model code that is relevant to the proposed building standards exists.)*

The adoption of the 1997 UPC is mandated by the Cailfornia Health and Safety Code, Division 13, part 1.5, section 17922(a)(3). As noted above, the proposed building standard would conform in part to section 604.1 of the 1997 UPC that was not adopted pending completion of the court ordered CEQA requirement. As described in detail above, the purposed building standard would allow the limited use of CPVC pipe when the local building official has made a determination that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions. Consequently, the proposed buildings standard would incorporate the appropriate model code in part.

8) The format of the proposed building standards is consistent with that adopted by the Commission.

The format of the proposed buildings standard to California Plumbing Code are in the form of a strike-out, underline change, and italic font. Therefore, the proposed building standard is consistent with the format adopted by the Commission.

9) The proposed building standards, if they promote fire and panic safety as determined by the State Fire Marshal, have the written approval of the State Fire Marshal.

The proposed building standard to the California Plumbing Code is not intended to promote fire and panic safety. Therefore, approval of the State Fire Marshal is not required. A copy of this proposed rulemaking is being submitted concurrently to the State Fire Marshal for review.

CERTIFICATE OF COMPLIANCE
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

The **DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT** hereby certifies that it has, within 120 days of the effective date of the emergency building standards attached hereto and which were filed with the Secretary of State on November 9, 2000, given notice of the adoption thereof and afforded interested persons the opportunity to present statements, arguments, or contentions in a manner substantially similar to that provided by Government Code Sections 11346.2-11346.9.

Julie Bornstein, Director
Department of Housing and Community Development

February 26, 2001
Date

BUILDING STANDARDS NOTICE/SUBMISSION

BSC-FACE SHEET (REV. 04/27/2000) Page I

Notice Register Number	Publication Date
•	January 12, 2001

Notice File Number: Z- 00-1227-01

Office of Administrative Law

Building Standards Commission

State Agency	Submittal #	Item #

Secretary of State

APPLICANTS – DO NOT USE THE ABOVE SPACE

1. PROPOSING AGENCY DIRECTOR OR DESIGNEE (Attach delegation order of designee)
Julie Bornstein, Director

STATE AGENCY
Department of Housing and Community Development

TELEPHONE NUMBER
(916) 323-7288

STREET ADDRESS: 1800 3rd Street, Suite 440
CITY: Sacramento
STATE: CA
ZIP CODE: 95814

FAX NUMBER
(916) 323-2815

2. SUBMITTAL – SUGGESTED REVISIONS TO THE CALIFORNIA CODE OF REGULATIONS, TITLE 24

SUBJECT: Limited use of CPVC pipe in residential buildings.

AGENCY FILE NUMBER:

3. NATURE OF PROCEEDINGS (GC §11346.5(a)(1))

PARTS/SECTIONS AFFECTED

Adopt CPC,Title 24, Part 5, Section 604.1b and Appendix I, Installation Standards for CPVC Solvent Cemented Hot and cold Water Distribution Systems, Section 301.0.

4. TYPE OF FILING

☐ Notice of Proposed Action ☐ Regular Rulemaking ☐ Resubmittal ☐ Emergency ☐ Other (Specify)

☒ Certification of Compliance: The agency officer named below certifies that this agency complies with the provisions of Government Code §§ 11346.6 – 11346.8 prior to, or within 120 days of, the effective date of the regulations contained in this filing.

☐ Changes without regulatory effect (Attach explanation and justification analysis supporting that the proposed change(s) does not materially alter any rights, responsibilities, conditions, prescription or other regulatory element of any California Code of Regulations provisions.

5. EFFECTIVE DATE OF REGULATORY CHANGE

☐ Effective 180 days after publication in the California Building Standards Code ☐ Effective 30th day after filing with the Secretary of State ☒ Effective on filing with Secretary of State ☐ Effective other (Specify)

6. AUTHORITY – Specify Statute(s) or Law(s) Authorizing the adoption(s) (GC §11346.2(a)(2) & §11346.5(2)):
Section 17921 and 17922 of the Health and Safety Code

7. REFERENCE – Provisions of law being implemented, interpreted or made specific by the regulations:
Section 17921 and 17922 of the Health and Safety Code

8. NAME AND TELEPHONE NUMBER OF THE AGENCY OFFICER TO WHOM INQUIRIES CONCERNING THE PROPOSED ACTION MAY BE DIRECTED
William J. Staack, Esq., P.E.--Staff Counsel (916) 323-7288

CERTIFICATION— IMPORTANT-- PLEASE READ BEFORE SIGNING-- If not signed, this application may be rejected.

I certify that the attached copy of regulation(s) is a true and correct copy of the regulation(s) identified in this filing, that the information specified in this filing is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to makes this certification. I further understand that any false, incomplete, or incorrect statements may result in the rejections of this filing.

AGENCY DIRECTOR OR DESIGNEE SIGNATURE

DATE SIGNED: 2/26/01

TYPE NAME AND TITLE OF SIGNATORY:

STATE OF CALIFORNIA
BUILDING STANDARDS COMMISSION

BUILDING STANDARDS NOTICE/SUBMISSION

BSC-FACE SHEET (REV. 04/27/2000) Page 1

RECEIVED

2001 FEB 27 AM 10:00

STANDARDS COMMISSION

Notice Register Number	Publication Date
•	January 12, 2001

Notice File Number: Z- 00-1227-01

Office of Administrative Law

Building Standards Commission

State Agency	Submittal #	Item #

Secretary of State

APPLICANTS – DO NOT USE THE ABOVE SPACE

1. PROPOSING AGENCY DIRECTOR OR DESIGNEE (Attach delegation order of designee)
Julie Bornstein, Director

STATE AGENCY
Department of Housing and Community Development

TELEPHONE NUMBER
(916) 323-7288

STREET ADDRESS
1800 3rd Street, Suite 440

CITY
Sacramento

STATE
CA

ZIP CODE
95814

FAX NUMBER
(916) 323-2815

2. SUBMITTAL – SUGGESTED REVISIONS TO THE CALIFORNIA CODE OF REGULATIONS, TITLE 24

SUBJECT: Limited use of CPVC pipe in residential buildings.

AGENCY FILE NUMBER:

3. NATURE OF PROCEEDINGS (GC §11346.5(a)(1))

PARTS/SECTIONS AFFECTED

Adopt CPC, Title 24, Part 5, Section 604.1b and Appendix I, Installation Standards for CPVC Solvent Cemented Hot and cold Water Distribution Systems, Section 301.0.

4. TYPE OF FILING

☐ Notice of Proposed Action ☐ Regular Rulemaking ☐ Resubmittal ☐ Emergency ☐ Other (Specify)

☒ Certification of Compliance: The agency officer named below certifies that this agency complies with the provisions of Government Code §§ 11346.6 – 11346.8 prior to, or within 120 days of, the effective date of the regulations contained in this filing.

☐ Changes without regulatory effect (Attach explanation and justification analysis supporting that the proposed change(s) does not materially alter any rights, responsibilities, conditions, prescription or other regulatory element of any California Code of Regulations provisions.

5. EFFECTIVE DATE OF REGULATORY CHANGE

☐ Effective 180 days after publication in the California Building Standards Code ☐ Effective 30th day after filing with the Secretary of State ☒ Effective on filing with Secretary of State ☐ Effective other (Specify)

6. AUTHORITY – Specify Statute(s) or Law(s) Authorizing the adoption(s) (GC §11346.2(a)(2) & §11346.5(2)):
Section 17921 and 17922 of the Health and Safety Code

7. REFERENCE – Provisions of law being implemented, interpreted or made specific by the regulations:
Section 17921 and 17922 of the Health and Safety Code

8. NAME AND TELEPHONE NUMBER OF THE AGENCY OFFICER TO WHOM INQUIRIES CONCERNING THE PROPOSED ACTION MAY BE DIRECTED
William J. Staack, Esq., P.E.--Staff Counsel (916) 323-7288

CERTIFICATION— IMPORTANT-- PLEASE READ BEFORE SIGNING-- If not signed, this application may be rejected.

I certify that the attached copy of regulation(s) is a true and correct copy of the regulation(s) identified in this filing, that the information specified in this filing is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to makes this certification. I further understand that any false, incomplete, or incorrect statements may result in the rejections of this filing.

AGENCY DIRECTOR OR DESIGNEE SIGNATURE

DATE SIGNED
2/26/01

TYPE NAME AND TITLE OF SIGNATORY:

RULEMAKING FILE INDEX

California Code of Regulations: Title 24, Part 5, Sections 604.1a, new section 604.1b, new section 301.0 in Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems.

Subject: The limited use of chlorinated polyvinyl chloride (CPVC) pipe in residential buildings in California.

1. - Building Standards Commission Face Sheet.
   - Certificate of Compliance.

2. Economic and Fiscal Impact Statement (Std. Form 399 rev. 2-98). Cost Assessment.

3. Public Notice.

4. Statement of Mailing Notice; Mailing List.

5. Express Terms of Proposed Regulations Made Available (Same as the Final Express Terms because no changes were made or required during the regulatory process).

6. Initial Statement of Reasons.

7. Written Comments (Note: no comments were received during 45-day Public Comment Period).

8. Updated Informative Digest.

9. Final Statement of Reasons.

10. Withdrawal letter for proposed amendments to section 604 of the California Plumbing Code previously filed with the Commission and identified as item 31 in the Commission's Monograph of Code Change Submittals for 1999.

11. Emergency Regulations Package for Limited Use of CPVC Pipe:
    - Building Standards Commission Face Sheet.
    - Finding of Emergency.
    - Form 399 Economic Impact Statement.
    - Express Terms (Note: Same as the Final Express Terms because no changes were made or required during the regulatory process).
    - Nine-Point Criteria Analysis.
    - Letter to the State Fire Marshal Office.

12. Approved Emergency Regulations Package for Limited Use of CPVC Pipe.

13. Information Bulletin #00-05 for Approved Emergency Regulations Package.

BEGINNING OF BACKGROUND INFORMATION

14. Court Approved Settlement Agreement for CPVC Pipe Use.

15. Rescinding Of The Certification And Notice Of Determination For The Final Environmental Impact Report Entitled "Chlorinated Polyvinyl Chloride (Cpvc) Pipe Used For Potable Water Piping In Residential Buildings," State Clearinghouse Number 970820040.

16. Draft Mitigated Negative Declaration for the Limited Use of CPVC pipe in Residential Buildings State Clearinghouse Number 2000091089.
    - Notice of Completion.
    - De Minimis Impact Finding.
    - Public Notice of Availability.
    - Draft Negative Declaration with Mitigation Measures, Initial Study.

17. Approval of Mitigated Negative Declaration for the Limited Use of CPVC pipe in Residential Buildings State Clearinghouse Number 2000091089.

I, the undersigned, certify that the attached items are originals or copies of the documents that compile the complete rulemaking file for the above-noted regulating activity, and that the date upon which the record of this rulemaking was closed is February, 26, 2001. I certify under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Signature:_____

Date:_____

Printed Name: William J. Staack, Esq., P.E. Place: Sacramento

Title: Staff Counsel

STATE OF CALIFORNIA
BUILDING STANDARDS COMMISSION

BUILDING STANDARDS NOTICE/SUBMISSION

BSC-FACE SHEET (REV. 04/27/2000) Page I

Notice Register Number	Publication Date
	January 12, 2001

Notice File Number: Z- 00-1227-01

Office of Administrative Law

Building Standards Commission

State Agency	Submittal #	Item #

Secretary of State

APPLICANTS – DO NOT USE THE ABOVE SPACE

1. PROPOSING AGENCY DIRECTOR OR DESIGNEE (Attach delegation order of designee)
Julie Bornstein, Director

STATE AGENCY
Department of Housing and Community Development

TELEPHONE NUMBER
(916) 323-7288

STREET ADDRESS
1800 3rd Street, Suite 440

CITY
Sacramento

STATE
CA

ZIP CODE
95814

FAX NUMBER
(916) 323-2815

2. SUBMITTAL – SUGGESTED REVISIONS TO THE CALIFORNIA CODE OF REGULATIONS, TITLE 24

SUBJECT: Limited use of CPVC pipe in residential buildings.

AGENCY FILE NUMBER:

3. NATURE OF PROCEEDINGS (GC §11346.5(a)(1))

PARTS/SECTIONS AFFECTED

Adopt CPC,Title 24, Part 5, Section 604.1b and Appendix I, Installation Standards for CPVC Solvent Cemented Hot and cold Water Distribution Systems, Section 301.0.

4. TYPE OF FILING

☐ Notice of Proposed Action ☐ Regular Rulemaking ☐ Resubmittal ☐ Emergency ☐ Other (Specify)

☒ Certification of Compliance: The agency officer named below certifies that this agency complies with the provisions of Government Code §§ 11346.6 – 11346.8 prior to, or within 120 days of, the effective date of the regulations contained in this filing.

☐ Changes without regulatory effect (Attach explanation and justification analysis supporting that the proposed change(s) does not materially alter any rights, responsibilities, conditions, prescription or other regulatory element of any California Code of Regulations provisions.

5. EFFECTIVE DATE OF REGULATORY CHANGE

☐ Effective 180 days after publication in the California Building Standards Code ☐ Effective 30th day after filing with the Secretary of State ☒ Effective on filing with Secretary of State ☐ Effective other (Specify)

6. AUTHORITY – Specify Statute(s) or Law(s) Authorizing the adoption(s) (GC §11346.2(a)(2) & §11346.5(2)):
Section 17921 and 17922 of the Health and Safety Code

7. REFERENCE – Provisions of law being implemented, interpreted or made specific by the regulations:
Section 17921 and 17922 of the Health and Safety Code

8. NAME AND TELEPHONE NUMBER OF THE AGENCY OFFICER TO WHOM INQUIRIES CONCERNING THE PROPOSED ACTION MAY BE DIRECTED
William J. Staack, Esq., P.E.--Staff Counsel (916) 323-7288

CERTIFICATION— IMPORTANT-- PLEASE READ BEFORE SIGNING-- If not signed, this application may be rejected.

I certify that the attached copy of regulation(s) is a true and correct copy of the regulation(s) identified in this filing, that the information specified in this filing is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to makes this certification. I further understand that any false, incomplete, or incorrect statements may result in the rejections of this filing.

AGENCY DIRECTOR OR DESIGNEE SIGNATURE

DATE SIGNED

TYPE NAME AND TITLE OF SIGNATORY:

CERTIFICATE OF COMPLIANCE
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

REGARDING THE CALIFORNIA PLUMBING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

When notice and hearing have occurred after the emergency adoption:

The **DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT** hereby certifies that it has, within 120 days of the effective date of the emergency building standards (or repealer) attached hereto and which were filed with the Secretary of State on November 9, 2000, given notice of the adoption thereof and afforded interested persons the opportunity to present statements, arguments, or contentions in a manner substantially similar to that provided by Government Code Sections 11346.2-11346.9.

STATE OF CALIFORNIA

ECONOMIC AND FISCAL IMPACT STATEMENT

(?ULATIONS AND ORDERS)

STD. 399 (REV. 2-98)

See SAM Sections 6000—6680 for Instructions and Code Citations

DEPARTMENT NAME	CONTACT PERSON	TELEPHONE NUMBER
Housing and Community Development	William Staack, Esq., P.E.	(916) 323-7288

DESCRIPTIVE TITLE FROM *NOTICE REGISTER* OR FORM 400

Regulations to approve the limited use of CPVC pipe for hot and cold-water distribution systems

NOTICE FILE NUMBER

ECONOMIC IMPACT STATEMENT

A. ESTIMATED PRIVATE SECTOR COST IMPACTS *(Include calculations and assumptions in the rulemaking record.)*

1. Check the appropriate box(es) below to indicate whether this regulation:

[ ] a. Impacts businesses and/or employees

[ ] b. Impacts small businesses

[ ] c. Impacts jobs or occupations

[ ] d. Impacts California competitiveness

[ ] e. Imposes reporting requirements

[ ] f. Imposes prescriptive instead of performance standards

[ ] g. Impacts individuals

[X] h. None of the above *(Explain below. Complete the Fiscal Impact Statement as appropriate.)*

h. *See Attachment "CPVC Fiscal Impact Statement Supplement."*

(If any box in Items 1.a. through g. is checked, complete this Economic Impact Statement.)

2. Enter the total number of businesses impacted: Describe the types of businesses *(Include nonprofits)*:

the number or percentage of total businesses impacted that are small businesses:

3. Enter the number of businesses that will be created: eliminated:

Explain:

4. Indicate the geographic extent of impacts: [ ] Statewide [ ] Local or Regional *(list areas)*:

5. Enter the number of jobs created: or eliminated Describe the types of jobs or occupations impacted:

6. Will the regulation affect the ability of California businesses to compete with other states by making it more costly to produce goods or services here?

[ ] Yes [ ] No If yes, explain briefly:

~~B. ESTIMATED COSTS *(Include calculations and assumptions in the rulemaking record).*~~

1. What are the total statewide costs that businesses and individuals may incur to comply with this regulation over its lifetime? $

a. Initial costs for a small business: $ Annual ongoing costs: $ Years:

b. Initial costs for a typical business: $ Annual ongoing costs: $ Years:

c. Initial costs for an individual: $ Annual ongoing costs: $ Years:

d. Describe other economic costs that may occur:

2. If multiple industries are impacted, enter the share of total costs for each industry: _____

3. If the regulation imposes reporting requirements, enter the annual costs a typical business may incur to comply with these requirements. *(Include the dollar costs to do programming, record keeping, reporting, and other paperwork, whether or not the paperwork must be submitted):* $ _____

4. Will this regulation directly impact housing costs? [ ] Yes [ ] No If yes, enter the annual dollar cost per housing unit: $ _____ and the number of units: _____

5. Are there comparable Federal regulations? [ ] Yes [ ] No Explain the need for State regulation given the existence or absence of Federal regulations: _____

Enter any additional costs to businesses and/or individuals that may be due to State – Federal differences: $ _____

C. ESTIMATED BENEFITS *(Estimation of the dollar value of benefits is not specifically required by rulemaking law, but encouraged.)*

1. Briefly summarize the benefits that may result from this regulation and who will benefit: _____

2. Are the benefits the result of: [ ] specific statutory requirements, or [ ] goals developed by the agency based on broad statutory authority? Explain: _____

3. What are the total statewide benefits from this regulation over its lifetime? $ _____

D. ALTERNATIVES TO THE REGULATION *(Include calculations and assumptions in the rulemaking record. Estimation of the dollar value of benefits is not specifically required by rulemaking law, but encouraged.)*

1. List alternatives considered and describe them below. If no alternatives were considered, explain why not: _____

2. Summarize the total statewide costs and benefits from this regulation and each alternative considered:

Regulation:	Benefit: $ _____	Cost: $ _____
Alternative 1:	Benefit: $ _____	Cost: $ _____
Alternative 2:	Benefit: $ _____	Cost: $ _____

3. Briefly discuss any quantification issues that are relevant to a comparison of estimated costs and benefits for this regulation or alternatives: _____

4. Rulemaking law requires agencies to consider performance standards as an alternative, if a regulation mandates the use of specific technologies or equipment, or prescribes specific actions or procedures. Were performance standards considered? [ ] Yes [ ] No Explain: _____

E. MAJOR REGULATIONS *(Include calculations and assumptions in the rulemaking record.)*

C ·PA boards, offices and departments are subject to the following additional requirements per Health and Safety Code section 57005.

1. Will the estimated costs of this regulation to California business enterprises exceed $10 million? [ ] Yes [ ] No *(If No, skip the rest of this section)*

2. Briefly describe each equally as effective alternative, or combination of alternatives, for which a cost-effectiveness analysis was performed:

Alternative 1: _____

Alternative 2: _____

5. For the regulation, and each alternative just described, enter the estimated total cost and overall cost-effectiveness ratio:

Regulation: $ _____ Cost-effectiveness ratio: _____

Alternative 1: $ _____ Cost-effectiveness ratio: _____

Alternative 2: $ _____ Cost-effectiveness ratio: _____

FISCAL IMPACT STATEMENT

A. FISCAL EFFECT ON LOCAL GOVERNMENT *(Indicate appropriate boxes 1 through 6 and attach calculations and assumptions of fiscal impact for the current year and two subsequent Fiscal Years)*

[ ] 1. Additional expenditures of approximately $_____ in the current State Fiscal Year which are reimbursable by the State pursuant to Section 6 of Article XIII B of the California Constitution and Sections 17500 et seq. of the Government Code. Funding for this reimbursement:

[ ] a. is provided in (Item _____, Budget Act of _____) or (Chapter _____, Statutes of _____)

[ ] b. will be requested in the _____ Governor's Budget for appropriation in Budget Act of _____
(FISCAL YEAR)

[ ] 2. Additional expenditures of approximately $_____ in the current State Fiscal Year which are not reimbursable by the State pursuant to Section 6 of Article XIII B of the California Constitution and Sections 17500 et seq. of the Government Code because this regulation:

[ ] a. implements the Federal mandate contained in _____

[ ] b. implements the court mandate set forth by the _____

court in the case of _____ vs. _____

[ ] c. implements a mandate of the people of this State expressed in their approval of Proposition No. _____ at the _____ election;
(date)

[ ] d. is issued only in response to a specific request from the _____

_____ which is/are the only local entity(s) affected;

[ ] e. will be fully financed from the _____ authorized by
(FEES, REVENUE, ETC)

Section _____ of the _____ Code;

[ ] f. provides for savings to each affected unit of local government which will, at a minimum, offset any additional costs to each such unit.

[ ] 3. Savings of approximately $ _____ annually.

[ ] 4. No additional costs or savings because this regulation makes only technical, non-substantive or clarifying changes to current law and regulations.

[ ] 5. No fiscal impact exists because this regulation does not affect any local entity or program.

[X] 6. Other. Minimal costs to local governments in affected areas. The proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings

B. FISCAL EFFECT ON STATE GOVERNMENT *(Indicate appropriate boxes 1 through 4 and attach calculations and assumptions of fiscal impact for the current year and two subsequent Fiscal Years.)*

[ ] 1. Additional expenditures of approximately $ _____ in the current State Fiscal Year. It is anticipated that State agencies will:

[ ] a. be able to absorb these additional costs within their existing budgets and resources.

[ ] b. request an increase in the currently authorized budget level for the _____ fiscal year.

[ ] 2. Savings of approximately $ _____ in the current State Fiscal Year.

[ ] 3. No fiscal impact exists because this regulation does not affect any State agency or program.

[X] 4. Other HCD will provide for periodic monitoring of the local implementation of the mitigation measures required for CPVC use. Costs will be absorbed through normal business operations.

C. FISCAL EFFECT ON FEDERAL FUNDING OF STATE PROGRAMS *(Indicate appropriate boxes 1 through 4 and attach calculations and assumptions of fiscal impact for the current year and two subsequent Fiscal Years.)*

[ ] 1. Additional expenditures of approximately $ _____ in the current State Fiscal Year.

[ ] 2. Savings of approximately $ _____ in the current State Fiscal Year.

[X] 3. No fiscal impact exists because this regulation does not affect any federally funded State agency or program.

[ ] 4. Other _____

SIGNATURE	Ted Neering for Julie Bornstein	TITLE DIRECTOR
AGENCY SECRETARY[1] / OVAL/CONCURRENCE		DATE 12/27/00
DEPARTMENT OF FINANCE[2] APPROVAL/CONCURRENCE	PROGRAM BUDGET MANAGER Shelley Mates	DATE 1/31/00

1. *The signature attests that the agency has completed the STD. 399 according to the instructions in SAM sections 6600-6680, and understands the impacts of the proposed rulemaking. State boards, offices, or departments not under an Agency Secretary must have the form signed by the highest ranking official in the organization.*

2. *Finance approval and signature is required when SAM sections 6600-6670 require completion of the Fiscal Impact Statement in the STD. 399. However, Finance must immediately receive a copy of each STD. 399 submitted to OAL without Finance signature, and Finance may subsequently question the no fiscal impact finding of a state agency.*

CPVC FISCAL IMPACT STATEMENT SUPPLEMENT

The proposed building standard is not mandatory and only provides an optional alternative to those persons who have metallic pipe corrosion problems in their residential buildings. Therefore, there will be no mandatory economic impacts on businesses and/or employees, small businesses, jobs or occupations, California competitiveness or individuals. There will also be no mandatory reporting requirements or imposed prescriptive standards.

The potential scope of CPVC use that will result from the proposed building standard should be limited because the information in the record indicates that metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence before the Department of Housing and Community Development (DHCD) indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. DHCD has made a determination that CPVC pipe is an effective alternative building material in those areas of the state with corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure.

Because of the limited scope that the option of CPVC plastic pipe will be authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, it is not expected that there will be an adverse reduction in the business of California metallic pipe manufacturers, distributors, and retailers that will eliminate jobs in California. Any potential losses would be offset by gains in the business of CPVC plastic pipe manufacture, distribution and retailing which would create jobs. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduced the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the DHCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

STATE OF CALIFORNIA - BUSINESS, TRANSPORTATION AND HOUSING AGENCY GRAY DAVIS, Governor
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
Division of Legal Affairs
1800 Third Street, Suite 440
P.O. Box 952052
Sacramento, CA 94252-2052
(916) 323-7288
FAX (916) 323-2815

December 22, 2000

Stan Nishimura,
Executive Director
California Building Standards Commission
1301 K Street, Suite 101
Sacramento, CA 95814

Re: Submission of Notice Package for the Limited Use of Chlorinated Polyvinyl Chloride (CPVC) Pipe for Potable Water Piping in Residential Buildings

Dear Mr. Nishimura;

The California Department of Housing and Community Development (HCD) is submitting the attached Notice Package in preparation for the March 14, 2001 Building Standards Commission Hearing. The Notice Package is for adoption of a building standard into Title 24, California Plumbing Code. This building standard, which was adopted by the Commission on November 8, 2000 as an Emergency Building Standard, is for statewide application and would expand the use of Chlorinated Polyvinyl Chloride (CPVC) pipe as an alternative material in residential buildings. CPVC pipe will be permitted for potable water piping only in those situations where the local building official has made a determination that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions and the installation is in compliance with specific mitigation measures.

HCD has approved a Mitigated Negative Declaration (SCH # 2000091089) for this building standard. This approved Mitigated Negative Declaration has satsified the California Environmental Quality Act requirements of the court order in *Cuffe v. California Building Standards Commission and the Department of Housing and Community Development*.

Enclosed are, one-Face Sheet and six-copies of the Notice with the Form 399, two-copies of the Express Terms, two-copies of the Initial Statement of Reasons, and 1 one-diskette containing required electronic files. These enclosures are required for submission of the Notice Package to the Building Standards Commission. If you have any questions or comments, please contact me at (916) 323-7288.

Sincerely,

William J. Staack

William J. Staack, Esq., P.E.
Staff Counsel

Enclosures

STATE OF CALIFORNIA
BUILDING STANDARDS COMMISSION

BUILDING STANDARDS NOTICE/SUBMISSION

BSC-FACE SHEET (REV. 04/27/2000) Page 1

Notice Register Number	Publication Date
2001, 22	1/12/01

Notice File Number: Z- 00-1227-01

RECEIVED FOR FILING: DEC 27 '00

PUBLICATION DATE: JAN 12 '01

Office of Administrative Law

RECEIVED
DEC 27 REC'D
BUILDING STANDARDS COMMISSION
Building Standards Commission

State Agency	Submittal #	Item #
HCD	EF 1/00	

Secretary of State

APPLICANTS – DO NOT USE THE ABOVE SPACE

1. PROPOSING AGENCY DIRECTOR OR DESIGNEE (Attach delegation order of designee)
Julie Bornstein, Director

STATE AGENCY: Department of Housing and Community Development
TELEPHONE NUMBER: (916) 323-7288

STREET ADDRESS: 1800 3rd Street, suite 440
CITY: Sacramento
STATE: CA
ZIP CODE: 95814
FAX NUMBER: (916) 323-2815

2. SUBMITTAL – SUGGESTED REVISIONS TO THE CALIFORNIA CODE OF REGULATIONS, TITLE 24
SUBJECT: Limited Use of CPVC Pipe in Residential Buildings
AGENCY FILE NUMBER:

3. NATURE OF PROCEEDINGS (GC §11346.5(a)(1))
PARTS/SECTIONS AFFECTED: Adopt CPC, Title 24, Part 5, Section 604.1b and Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, Section 301.0

4. TYPE OF FILING
[X] Notice of Proposed Action [ ] Regular Rulemaking [ ] Resubmittal [ ] Emergency [ ] Other (Specify)

[ ] Certification of Compliance: The agency officer named below certifies that this agency complies with the provisions of Government Code §§ 11346.6 – 11346.8 prior to, or within 120 days of, the effective date of the regulations contained in this filing.

[ ] Changes without regulatory effect (Attach explanation and justification analysis supporting that the proposed change(s) does not materially alter any rights, responsibilities, conditions, prescription or other regulatory element of any California Code of Regulations provisions.

5. EFFECTIVE DATE OF REGULATORY CHANGE
[ ] Effective 180 days after publication in the California Building Standards Code [ ] Effective 30th day after filing with the Secretary of State [ ] Effective on filing with Secretary of State [ ] Effective other (Specify)

6. AUTHORITY – Specify Statute(s) or Law(s) Authorizing the adoption(s) (GC §11346.2(a)(2) & §11346.5(2)):
Sections 17921 and 17922 of the Health and Safety Code

7. REFERENCE – Provisions of law being implemented, interpreted or made specific by the regulations:
Sections 17921 and 17922 of the Health and Safety Code

8. NAME AND TELEPHONE NUMBER OF THE AGENCY OFFICER TO WHOM INQUIRIES CONCERNING THE PROPOSED ACTION MAY BE DIRECTED
Bill Staack, Esq., P.E., DHCD Staff counsel @ (916) 323-7288

CERTIFICATION— IMPORTANT-- PLEASE READ BEFORE SIGNING-- If not signed, this application may be rejected.

I certify that the attached copy of regulation(s) is a true and correct copy of the regulation(s) identified in this filing, that the information specified in this filing is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to makes this certification. I further understand that any false, incomplete, or incorrect statements may result in the rejections of this filing.

AGENCY DIRECTOR OR DESIGNEE SIGNATURE: [signature]
DATE SIGNED: 12/21/00

TYPE NAME AND TITLE OF SIGNATORY: Julie Bornstein, Director

State of California
State and Consumer Services Agency

California Building Standards Commission
1130 K Street, Suite 101, Sacramento, CA 95814
(916) 323-6363; FAX (916) 443-6008

Memorandum

Date: December 29, 2000

To: Mr. William J. Staack, Staff Counsel
Division of Legal Affairs
Department of Housing and Community Development
1800 Third Street, Suite 400
Sacramento, CA 95814

From: Stan Nishimura
Executive Director

Subject: 45-Day Notice of Proposed Action – LIMITED USE OF CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE IN RESIDENTIAL BUILDINGS

Please disregard the first memorandum sent to you on December 28, 2000. The Office of Administrative Law (OAL) reviewed the CPVC notice and requested that minor changes be made. The attached document reflects the changes. OAL has stated that this notice meets with their approval.

Pursuant to Health and Safety Code Section 18935(a), the notice of proposed building standards and the initial statement of reasons for the subject proposed building standards have been reviewed for compliance with Article 5 (commencing with Section 11346) of Title 2 of the Government Code. The Commission approves the notice and initial statement of reasons, and has submitted them to the Office of Administrative Law on December 27, 2000 for inclusion in the January 12, 2001 *California Regulatory Notice Register*. Attached is a copy of the material submitted to the Office of Administrative Law for your use and records. The 45-Day Notice period commences on January 12, 2001 and closes on February 26, 2001 at 5:00 P.M.

Please be advised that your agency must mail the notice to every person who has filed a request for notice of regulatory action with your agency and to a representative number of small business enterprises or their representative, which have been identified as being affected, by this proposed action. The notice must be mailed at least 45-days prior to the public hearing, if held, and to the close of the comment period pursuant to Government Code Section 18934.

This notice has been given identification number HCD 1/00. When contacting or submitting future material to the Commission, please reference this identification number. Should you have any questions, please contact me at 323-1071 or Leslie R. Williams at 323-0118.

Attachments

cc: Trade & Commerce, Regulations Review Unit w/attachments
Leslie Williams
Chron File
Project File

STATE OF CALIFORNIA
BUILDING STANDARDS COMMISSION

BUILDING STANDARDS NOTICE/SUBMISSION

BSC-FACE SHEET (REV. 04/27/2000) Page 1

Notice Register Number	Publication Date
Notice File Number: Z- 00-1227-01	
RECEIVED FOR FILING	PUBLICATION DATE
DEC 27 '00	JAN 12 '01

Office of Administrative Law

Office of Administrative Law

RECEIVED
DEC 27 REC'D
BUILDING STANDARDS COMMISSION

Building Standards Commission

State Agency	Submittal #	Item #
HCD	EF 1/00	

Secretary of State

APPLICANTS – DO NOT USE THE ABOVE SPACE

1. PROPOSING AGENCY DIRECTOR OR DESIGNEE (Attach delegation order of designee)
Julie Bornstein, Director

STATE AGENCY: Department of Housing and Community Development — TELEPHONE NUMBER: (916) 323-7288

STREET ADDRESS: 1800 3rd Street, suite 440 — CITY: Sacramento — STATE: CA — ZIP CODE: 95814 — FAX NUMBER: (916) 323-2815

2. SUBMITTAL – SUGGESTED REVISIONS TO THE CALIFORNIA CODE OF REGULATIONS, TITLE 24
SUBJECT: Limited Use of CPVC Pipe in Residential Buildings

AGENCY FILE NUMBER:

3. NATURE OF PROCEEDINGS (GC §11346.5(a)(1))

PARTS/SECTIONS AFFECTED — Adopt CPC, Title 24, Part 5, Section 604.1b and Appendix I, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, Section 301.0

4. TYPE OF FILING

[X] Notice of Proposed Action [ ] Regular Rulemaking [ ] Resubmittal [ ] Emergency [ ] Other (Specify)

[ ] Certification of Compliance: The agency officer named below certifies that this agency complies with the provisions of Government Code §§ 11346.6 – 11346.8 prior to, or within 120 days of, the effective date of the regulations contained in this filing.

[ ] Changes without regulatory effect (Attach explanation and justification analysis supporting that the proposed change(s) does not materially alter any rights, responsibilities, conditions, prescription or other regulatory element of any California Code of Regulations provisions.

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[ ] Effective 180 days after publication in the California Building Standards Code [ ] Effective 30th day after filing with the Secretary of State [ ] Effective on filing with Secretary of State [ ] Effective other (Specify)

6. AUTHORITY – Specify Statute(s) or Law(s) Authorizing the adoption(s) (GC §11346.2(a)(2) & §11346.5(2)):
Sections 17921 and 17922 of the Health and Safety Code

7. REFERENCE – Provisions of law being implemented, interpreted or made specific by the regulations:
Sections 17921 and 17922 of the Health and Safety Code

8. NAME AND TELEPHONE NUMBER OF THE AGENCY OFFICER TO WHOM INQUIRIES CONCERNING THE PROPOSED ACTION MAY BE DIRECTED
Bill Staack, Esq., P.E., DHCD Staff counsel ● (916) 323-7288

CERTIFICATION— IMPORTANT– PLEASE READ BEFORE SIGNING– If not signed, this application may be rejected.

I certify that the attached copy of regulation(s) is a true and correct copy of the regulation(s) identified in this filing, that the information specified in this filing is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to makes this certification. I further understand that any false, incomplete, or incorrect statements may result in the rejections of this filing.

AGENCY DIRECTOR OR DESIGNEE SIGNATURE — DATE SIGNED: 12/21/00

TYPE NAME AND TITLE OF SIGNATORY: Julie Bornstein, Director

NOTICE OF PUBLIC HEARING AND PROPOSED CHANGES
IN
BUILDING STANDARDS
OF THE
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
REGARDING THE CALIFORNIA PLUMBING CODE
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 5

Notice is hereby given that the California Building Standards Commission, on behalf of Department of Housing and Community Development, ***has adopted (November 14, 2000) on an emergency basis, the regulatory changes described in the Informative Digest, which the Commission*** now proposes to formally adopt, approve, codify, and publish as building standards contained in the California Code of Regulations (CCR), Title 24, Part 5. ***These building standards are related to the limited use of Chlorinated Polyvinyl Chloride (CPVC) Pipe for use in residential buildings.***

PUBLIC HEARING

A public hearing has not been scheduled; however, written comments will be accepted from January 12, 2001 to February 26, 2001, until 5:00 p.m. Please address your comments to:

Leslie R. Williams
California Building Standards Commission,
1130 K Street, Suite 101,
Sacramento, CA 95814
E-Mail Address: lewillia@dgs.ca.gov
Fax Telephone Number: (916) 443-6008

Pursuant to Government Code Section 11346.8, any interested person or his or her duly authorized representative may request, no later than 15 days prior to the close of the written comment period, that a public hearing be held.

AUTHORITY AND REFERENCE

The California Building Standards Commission proposes to adopt this building standard under the authority granted by Health and Safety Code Section 18949.5. The purpose of this building standard is to implement, interpret, and make specific the provisions of Health and Safety Code Sections 17921 and 17922 of the State Housing Law. The Department of Housing and Community Development is proposing this regulatory action based on Health and Safety Code Sections 17921 and 17922.

INFORMATIVE DIGEST

Summary of Existing Laws

The purpose of these building standards is to implement, interpret, and make specific the provisions of Health and Safety Code Sections 17921 and 17922 of the State Housing Law.

- Health and Safety Code Section 17921 requires that HCD propose the adoption, amendment, or repeal of building standards to CBSC for the protection of the public health, safety and the construction, repair and maintenance of all hotels, motels, lodging houses, apartment houses and dwellings.

- Health and Safety Code Section 17922 (a) requires that HCD propose the adoption of uniform industry codes, including the Uniform Plumbing Code (UPC) published by the International Conference of Building Officials (ICBO) and the International Association of Plumbing and Mechanical Officials (IAPMO).

The Department of Housing and Community Development (HCD) has been directed by the Legislature to propose for adoption in the California Plumbing Code, substantially as published, uniform industry codes, including the Uniform Plumbing Code (UPC) published by the International Association of Plumbing and Mechanical Officials (IAPMO) (Health and Safety Code sec. 17922(a)). Beginning with the 1982 edition of the UPC, chlorinated polyvinyl chloride (CPVC) plastic pipe was permitted for use inside residential buildings for hot and cold-water distribution. However, the predecessor to the California Building Standards Commission (CBSC) determined that an Environmental Impact Report (EIR) prepared pursuant to the requirements of the California Environmental Quality Act (CEQA) was needed before approving this expanded use of CPVC plastic pipe in the California Building Code. As part of the adoption of the 1982 UPC, HCD proposed and the CBSC adopted California Plumbing Code section 604.1a, which prohibits the use of CPVC for hot and cold-water distribution within residential buildings in California pending compliance with CEQA. Section 604.1a has remained a part of the California Plumbing Code ever since, even though each successive edition of the UPC has permitted this use of CPVC. The rationale for the continuing prohibition in the California Plumbing Code was the delayed completion of the EIR.

In October 1995, AB 151 (Stats. 1995. c. 785) was signed into law and allowed the use of CPVC plastic pipe as an alternate building material in residential buildings under specified conditions. HCD subsequently filed and the CBSC subsequently approved emergency regulations, which had the effect of permitting the use of CPVC plastic pipe for hot and cold-water distribution inside buildings on a statewide basis. This action was successfully challenged in court on the ground that the decision to allow the expanded use of CPVC plastic pipe was a discretionary action subject to the requirements of CEQA. (*Cuffe* v. *California Building Standards Commission and the California Department of Housing and Community Development* (Superior Court of San Francisco, File No. 300221).)

In compliance with the court's order, HCD performed a preliminary environmental assessment and determined that it would be prudent to prepare a full environmental impact report. HCD completed and certified an EIR (The Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings; State Clearinghouse Number 90820040; prepared by the Department of Housing & Community Development and certified December 1, 1998, hereinafter referred to as the "CPVC EIR"). The CPVC EIR concluded that permitting the use of CPVC plastic pipe for statewide use for hot and cold-water distribution within residential buildings would not result in any significant environmental impacts.

A court challenge to the 1998 certified CPVC EIR resulted in a settlement agreement to allow the limited use of CPVC pipe in residential buildings. This regulatory proposal and a November 2000 Certified Negative Declaration with Mitigation Measures have been prepared pursuant to this settlement agreement. The Certified Negative Declaration satisfies the CEQA requirement of the court in *Cuffe* v. *California Building Standards Commission, et al.*, see *supra*. The finding of the Negative Declaration for the proposed building standard was that given the limited scope of the project, and/or provided the proposed mitigation measures were complied with, the implementation of the building standard would not result in any significant environmental impacts or potential health hazards to the homeowner or installer of the CPVC pipe. The settlement agreement provides for rescission of the 1998 certified CPVC EIR and withdrawal of the previous proposed building standard approving CPVC use on a statewide basis. The settlement agreement would allow a building standard for the limited use of CPVC pipe in residential buildings upon a finding by the local building official that there is or will be the premature failure of metallic pipe due to corrosive water and/or soil conditions. The settlement agreement required specific conditions and mitigation measures to be included in the building standard and also provides that HCD issue an Information Bulletin to all local building officials informing them of the specific conditions and mitigation measures required for local approvals of CPVC. Furthermore, the settlement agreement also provides for HCD's periodic monitoring of the local implementation of the mitigation measures required for CPVC use.

Summary of Existing Regulations

The Uniform Plumbing Code section 604.1 permits this use of CPVC plastic pipe in residential buildings; however, HCD did not adopt section 604.1. HCD adopted an amendment, section 604.1a into the California Plumbing Code, Title 24, Chapter 6, that does not permit the use of CPVC plastic pipe for purposes of hot and cold-water distribution within residential buildings (HCD 1 and HCD 2 occupancies).

Summary of Effect

The proposed action is to amend existing California Plumbing Code Title 24 by adding new section 604.1b to Chapter 6 and by adding section 301.0 to Appendix I, "Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems." These new sections incorporate specific mitigation measures that are

necessary to comply with the CEQA requirements for the November 2000 certified Negative Declaration with Mitigation Measures.

If adopted, the proposed building standard would grant local building officials the authority to approve the limited use of CPVC pipe for hot and cold-water distribution systems within residential buildings subject to specified conditions and mitigation measures that are incorporated into the regulatory proposal. A local building official would be authorized to approve the use of CPVC only if he or she first determines that there is or will be a premature failure of metallic pipe if installed in such residential buildings due to corrosive water and/or soil conditions. Any building permit issued by the local building official authorizing the use of CPVC based on such a finding would be conditioned on compliance with the specific mitigation measures in the building standard.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the potential scope of CPVC use that will result from the proposed building standard will be limited. Information in the record of previous HCD examinations of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before HCD indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the HCD has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

Comparable Federal Statute or Regulations

CPVC pipe is approved for use in manufactured residential homes for hot and cold-water distribution systems through the federal National Manufactured Housing Construction and Safety Standards Act of 1974. This Act preempts state regulations of manufactured housing construction standards.

Small Business Affect

As discussed above in the "Summary of Effect," the potential scope of CPVC use that will result from the proposed building standard should be limited because the information in the record indicates that metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence before HCD indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. HCD has made a determination that CPVC pipe is an effective alternative building material in those areas of the state with corrosive water and/or soil conditions because the CPVC material is not susceptible to corrosive failure. For these reasons, the HCD has concluded that CPVC pipe is an acceptable alternative for premature failed metallic pipe, but that the resulting installation of CPVC pipe in California from the proposed regulatory approval

will be limited in scope.

To the extent that CPVC plastic pipe is authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, there could be some reduction in the business of California metallic pipe manufacturers, distributors, and retailers. However, these potential losses would be offset by gains in the business of CPVC plastic pipe manufacture, distribution and retailing. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduce the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the HCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

Policy Statement Overview:

There are some areas in California where residential buildings have been faced with failed water systems because the installed metallic pipe has failed prematurely due to corrosive water and/or soil conditions, resulting in property damage and financial hardship to both businesses and homeowners. The purpose of the proposed building standard is to give new home construction and existing homeowners a permanent solution to end the cycle of premature failed metallic pipe by allowing the homes to be initially installed with, or in the case of failure of existing metallic pipe to be re-piped with, chlorinated polyvinyl chloride (CPVC) pipe.

The proposed building standard regarding the California Plumbing Code, Part 5 of Title 24 of the California Code of Regulations (CCR) will alleviate unnecessary financial hardships caused by premature failure of metallic pipe in residential buildings. Specifically, they will permit the limited use of CPVC pipe in residential building where it is determined by a local building official that there is or will be the premature failure of metallic pipe and the pipe is installed pursuant to specified mitigation measures.

Because the local CPVC approval authority that would be granted by the proposed building standard requires findings of existing or expected metallic pipe failure due to corrosive water and/or soil conditions, the potential scope of CPVC use that will result from the proposed building standard will be limited. Information in the record of CPVC pipe indicates that problems with corrosive water and/or soil conditions exist throughout California, but is not a widespread problem. The evidence before the Department of Housing and Community Development (HCD) indicates that metallic pipe corrosion has been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells. For these reasons, the HCD has concluded that the CPVC installations that may result from the proposed regulatory approval will be limited in scope.

The proposed building standard contains the following conditions:

1. A local building official would be authorized to approve the use of CPVC only if that official determines that there is or will be a premature failure of metallic pipe.
2. Any building permit issued by the local building official authorizing the use of CPVC would be conditioned on compliance with specific measures described in the regulations.
3. Only approved CPVC plumbing piping could be used.
4. Installations and uses of CPVC would be required to comply with all applicable requirements of the California Plumbing Code.
5. Prior to issuing a building permit authorizing use of CPVC, the contractor must provide certain written certifications.
6. Final permit approval cannot be given unless the material has been installed in compliance with the requirements of the California Plumbing Code.
7. A contractor not installing CPVC correctly would be subject to penalties.

MATTERS PRESCRIBED BY STATUTE APPLICABLE TO THE AGENCY OR TO ANY SPECIFIC REGULATION OR CLASS OF REGULATIONS

California Environmental Quality Act (CEQA): Title 25, California Code of Regulations, section 6971(b)(1) requires the HCD to make an initial assessment whether an activity may have a significant effect on the environment. As discussed above, CEQA compliance was also required as a result of a court challenge to the use of CPVC pipe in residential buildings. (*Cuffe* v. *California Building Standards Commission, et al.*, see *supra.*) In November 2000, HCD certified a Negative Declaration with Mitigation Measures for the proposed building standard. The certified Negative Declaration concludes that the proposed building standard, which permits the limited use of CPVC plastic pipe for hot and cold-water distribution within residential buildings, would not result in any significant environmental impacts if all the mitigation measures were implemented.

MANDATE ON LOCAL AGENCIES OR SCHOOL DISTRICTS

The Department of Housing and Community Development has determined that the proposed regulatory action would not impose a mandate on local agencies or school districts, therefore does not mandate state reimbursement pursuant to Part 7 (commencing with Section 17500) of Division 4 of the Government Code.)

FISCAL IMPACT STATEMENT (attached Form 399)

A. Cost or Savings to any state agency: **NO**

B. Cost to any local agency required to be reimbursed under Part 7(commencing with Section 17500) of Division 4: **NO**

C. Cost to any school district required to be reimbursed under Part 7 (commencing with Section 17500) of Division 4: **NO**

D. Other nondiscretionary cost or savings imposed on local agencies: **NO**

E. Cost or savings in federal funding to the state: **NO**

Estimate: **NONE**

ECONOMIC IMPACT ON BUSINESSES

The DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT has made an initial determination that the adoption of this regulation MAY NOT have a significant adverse economic impact on businesses, including the ability of California businesses to compete with businesses in other states. The DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT HAS NOT considered proposed alternatives that would lessen any adverse economic impact on businesses.

Because the application of this building standard is very limited, the HCD does not anticipate an adverse economic impact on businesses, including the ability of California businesses to compete with business in other states nor will the building standard have an affect on small businesses in California.

As discussed in the record that supports the Mitigated Negative Declaration the potential scope of CPVC use that will result from the proposed building standard will be limited because the metallic piping problems associated with corrosive water and/or soil conditions are not a widespread problem in California. The evidence in the record before HCD indicates that the problems with metallic pipe corrosion have been isolated and occurred significantly only in certain limited areas of the state where residential units are being served by underground water wells.

Because of the limited scope that CPVC plastic pipe will be authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, it is not expected that there will be an adverse reduction in the business of California metallic pipe manufacturers, distributors, and retailers. However, any potential reductions would be offset by gains in the business for CPVC plastic pipe manufacture, distribution and retailing.

Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduce the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the HCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

FINDING OF NECESSITY FOR THE PUBLIC'S HEALTH, SAFETY, OR WELFARE

HCD has made an assessment of the proposed code change and has determined that a report is not required.

ASSESSMENT OF EFFECT OF REGULATIONS UPON JOBS AND BUSINESS EXPANSION, ELIMINATION OR CREATION

The DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT is not aware of any costs impacts that a business would necessarily incur in reasonable compliance with the proposed action and has assessed whether or not and to what extent this proposal will affect the following:

The creation or elimination of jobs within the State of California:

Because of the limited scope that CPVC plastic pipe will be authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, it is not expected that there will be an adverse reduction in the business of California metallic pipe manufacturers, distributors, and retailers that will eliminate jobs in California. Any potential losses would be offset by gains in the business of CPVC plastic pipe manufacture, distribution and retailing, which would create jobs. Because CPVC plastic pipe may require different installation skills, and because CPVC will have a longer service life than the metallic pipe that it is replacing because of the corrosion problem, the limited use of CPVC plastic pipe may reduce the frequent metallic pipe replacement requirement for skilled plumbing trades persons. However, it is the opinion of the HCD that any potential losses in these trades would not be significant because of the limited scope of the building standard and would be more than offset by increases in construction work statewide where CPVC pipe would not be authorized to replace metallic pipe.

The creation of new businesses or the elimination of existing businesses within the State of California:

Because of the limited scope that CPVC plastic pipe will be authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, it is not expected that there will be an adverse reduction in existing business of California metallic pipe manufacturers, distributors, and retailers. Any potential losses would be offset by potential creation of new businesses for CPVC plastic pipe manufacture, distribution and retailing.

The expansion of businesses currently doing business within the State of California:

Because of the limited scope that CPVC plastic pipe will be authorized by a local building official when a determination has been made that there is or will be the premature failure of metallic pipe in residential buildings, it is not expected that there will be an adverse reduction in the growth of business of California metallic pipe manufacturers, distributors, and retailers. However, any potential losses would be offset by gains in the growth of business of CPVC plastic pipe manufacture, distribution and retailing.

SIGNIFICANT EFFECT ON HOUSING COSTS

The DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT has made an initial determination that this proposal WOULD NOT have a significant effect on housing costs. The CBSC contact designated below will make the DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT evaluation of the effect of the proposed regulatory action on housing costs available upon request.

EFFECT ON PRIVATE PERSONS

The Department of Housing and Community Development is not aware of any cost impacts that a representative private person would necessarily incur in reasonable compliance with the proposed action.

FEDERALLY-MANDATED REGULATIONS

This regulation is not federally mandated nor is any provisions identical to a previously adopted or amended federal regulation.

REASONABLE ALTERNATIVES

The Department of Housing and Community Development (HCD) must determine that no reasonable alternative considered or that has otherwise been identified and brought to the attention of HCD would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons that the proposed action. This determination has been made by HCD.

POST-HEARING MODIFICATIONS TO THE TEXT OF THE REGULATIONS

Following the public comment period, the CBSC may adopt the proposed regulations substantially as proposed in this notice or with modifications, which are sufficiently related to the original proposed text, and notice of proposed regulatory activity. If modifications are made, the full text of the proposed action with the changes clearly indicated will be made available to the public for at least 15 days prior to the date on which the CBSC adopts,

amends, or repeals the regulation(s). The CBSC will accept written comments on the modified regulations during the 15-day period.

AVAILABLE DOCUMENTS

Copies of the ISOR and the Express Terms are prepared and available upon request by contacting the CBSC, Staci Vallejo at (916) 323-0143 or svallejo@dgs.ca.gov or Fax at (916) 443-6008 and CBSC's homepage at www.bsc.ca.gov. The Rulemaking File will be available between the hours of 9:00 AM and 4:30 PM, Monday through Friday for inspection at:

California Building Standards Commission,
1130 K Street, Suite 101,
Sacramento, CA 95814

Note: In the event the contact person is unavailable contact Leslie R. Williams at (916) 323-0118 or lewillia@dgs.ca.gov and by fax at (916) 443-6008.

When the Final Statement of Reasons for this building standard is available for review, it will be available at the locations listed above.

CONTACT PERSON FOR SUBSTANTIVE QUESTIONS ON BUILDING STANDARD

Specific questions regarding the substantive aspects of the building standard should be addressed to the person below, or to the Legal Affairs Division of the Department of Housing and Community Development at (916) 323-7288.

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
E-mail: BStaack@hcd.ca.gov
Fax (916) 323-2815

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF CODES AND STANDARDS
1800 THIRD STREET, SUITE 260. P.O. BOX 1407
SACRAMENTO, CALIFORNIA 95812-1407
(916) 445-9471 FAX (916) 327-4712
From TDD Phones 1 (800) 735-2929

STATEMENT OF MAILING
NOTICE OF PROPOSED REGULATORY ACTIVITY

I Sharen Scott do declare under penalty of perjury the following:

On January 16, 2001, I mailed copies of the Notice of Proposed Rulemaking Activity in compliance with government Code section 11346.4, subdivision (a), (a)(1), (a)(2), (a)(3), and (a)(4). I deposited these documents with the United States Postal Service at least forty-five days prior to the public hearing and the close of the public comment period.

By: Sharen B Scott

Title: SSMI

Sacramento City/Sacramento County

Date: February 16, 2001

MAIN STATE HOUSING AUTHORITY	ATTN. T. M. HASSETT	320 WATER STREET		AUGUSTA, ME 04333
ALBI MFG DIV OF STANCHEM, INC.	ATTN: WM. H. MC LAIN	401 BERLIN STREET		EAST BERLIN, CT 06023
PTL - INSPECTORATE, INC.	850 POPLAR STREET			PITTSBURG, PA 15220
ANTHONY SCARANO	1319 MOON DRIVE			YARDLEY, PA 19067
ANTHONY SCARANO	3 SPRINGDALE TERRACE			MORRISVILLE, PA 19067
DU PONT COMPANY	ATTN: DEBORAH DONOVA	LEGAL DEPT. D 7037		WILMINGTON, DE 19898
EARL R. BELL, ARCH	USDA-FM HA-PSS ROM. 5447 S. AG.			WASHINGTON, DC 20250
HARDWOOD PLYWOOD MFGRS. ASSN.	P.O BOX 2789			RESTON, VA 22090
HARDWOOD PLYWOOD MFRS. ASSN.	P.O. BOX 2789			RESTON, VA 22090
CODE COMPLIANCE COUNCIL	S B STAFFORD	ATTN: S. B. STAFFORD		GREENSBORO, NC 27405
BUILDING INSPECTOR III	ROBERT H MASSEY	SAN BERNARDINO COUNTY	2007 YAMLEYVILLE ST. SUITE 228	SAN BERNARDINO, CA 29415-0315
WOODS ENTERPRISES	P.O. BOX 1949		172 WEST 3RD STREET, 6TH FLOOR	DECATUR, GA 30031-1949
H.W.C AND ASSOCIATES, INC.	ROBERT JOHNSON	1627 SOUTH MYRTLE AVE.		CLEARWATER, FL 34616
PLASTIC PIPE FITTING ASSN.	ATTN: JACK LANDCASTER	RT. 1, BOX 370		BRIGHTON, TN 38011
PUBLIC UTILITIES COMMISSION	ALOK KUMAR, P.E.	505 VAN NESS AVENUE		SAN FRANCISCO,, C9 4102
MOEN INCORPORATED	AMY POTENTE	PRODUCT COMPLIANCE COORDINATOR	25300 AL MOEN DRIVE	NORTH OLMSTED, OH 44070
CITY OF CINCINATTI	COMMISSIONER OF BUILDING/DEPT PUBLIC WRK	CITY HALL - ROOM 328		CINCINATTI, OH 45202
T H ARNOLD & ASSOC., INC.	P.O. BOX 1081			ELKHART, IN 46514
T.R. ARNOLD & ASSOCIATES, INC.	P.O. BOX 1081	P.O. BOX 1081		ELKHART, IN 46514
T R ARNOLD AND ASSOCIATES, INC.	THEODORE HUFF	58640 STATE RD. 15		ELKHART, IN 46515
PROGRESSIVE ENGINEERING, INC.	NED MYERS	P.O. BOX 490		GOSHEN, IN 46526
NTA, INC.	DENNIS NORKUS			NAPPANEE, IN 46550-0490
AFFORDABLE LUXURY HOME, INC.	P.O. BOX 288 U.S. 224 WEST	1600 E. WASHINGTON BLVD.		MARKLE,, IN 46770
INDIANA INSTITUTE OF TECHNOLOGY	RESEARCH AND DEVELOPMENT LAB	P.O. BOX 2450		FORT WAYNE, IN 46803
FORMOST INSURANCE	GEORGE CAREY	333 PFINGSTEN RD.		GRAND RAPIDS, MI 49501
UNDERWRITERS LABORATORIES (R.V. ONLY)	DAVE OTTO			NORTHBROOK, IL 60062-2096
PORTLAND CEMENT ASSOCIATION	5420 OLD ORCHARD ROAD	4051 W. FLOSSMOOR ROAD		SKOKIE, IL 60076
BUILDING OFFICIALS & CODE	ADMINISTRATOR INTERNATIONAL	4051 W. FLOSSMOOR ROAD		COUNTRY CLUB HILLS, IL 60477
BLDG OFFICIALS & CODE ADMIN. INTL.	ATTN: C.R. BECHTEL			COUNTRY CLUB HILLS, IL 60477
ENVIROVAC	1260 TURRET DRIVE	6718 PLANK ROAD	P.O BOX 2000	ROCKFORD, IL 61111
UNR-ROHN	MIKE FLESSNER			PEORIA, IL 61656
MONSANTO COMPANY	800 N. LINDBERG BOULEVARD	800 N. LINDBERG BLVD.		ST. LOUIS, MO 63166
MONSANTO COMPANY (E2SC)	800 NORTH LINDBERG BOULEVARD	P.O. BOX 389		ST. LOUIS, MO 63166
MONSANTO (EZSC)	MONSANTO (EZSC)			ST. LOUIS, MO 63166
CRANE COMPANY	ATTN: WM. E. OLSEN	P.O. BOX 6561		NEVADA, MO 64772
ALUMAX ALUMINUM CORPORATION	P. O. BOX 163	ONE SHELL PLAZA - P.O. BOX 2463		MESQUITE, TX 75149
CONINE MANUFACTURING CO., INC.	ATTN: VIRGIL CONINE	1621 18TH ST., SUITE 200		TYLER, TX 75711
SHELL OIL COMPANY	ATTN: STEVE PREGUN			HOUSTON, TX 77001
URBAN DESIGN GROUP	ARCHITECTURE/PLANNING	(R.V. AND SPCC ONLY)		DENVER, CO 80202
PATTERSON BALLARD & ASSOC. INC.	951 WARNER COURT, SUITE 330		437 SOUTH SPRUCE STREET	CASPER, WY 82601
PATTERSON, WEBER AND ASSOC., INC.	HARRY PATTERSON			CASPER, WY 82601
INTERNATIONAL HOUSING DIV.	P. O. BOX 154			SMITHFIELD, UT 84335
KENNETH KINDSEY	119 SO. CLARK DR.			TEMPE, AZ 85281
L.A. DEPT. OF WATER & POWER	111 N. HOPE STREET	BUILDING OFFICIAL	201 FIGUEROA STREET	LOS ANGELES, CA 90012
CITY OF LOS ANGELES	ANDREW ADELMAN	313 N. FIGUEROA, ROOM 331		LOS ANGELES, CA 90012
HLTH SVCS HSG/INSTUTIONS PRGM	ATTN: TOM BARNETT	200 N. SPRING STREET		LOS ANGELES, CA 90012
MAIN CITY HALL, ROOM 490	BILL KING	200 N. SPRING STREET		LOS ANGELES, CA 90012
MAIN CITY HALL, ROOM 490	DAVE MacLEAN	200 N. SPRING STREET		LOS ANGELES, CA 90012
MAIN CITY HALL, ROOM 490	GARY WILSON	200 N. SPRING STREET		LOS ANGELES, CA 90012
MAIN CITY HALL, ROOM 490	GRACE HARPER	111 N. HOPE STREET		LOS ANGELES, CA 90012
LOS ANGELES DEPT OF WATER & POWER	LOS ANGELES DEPT OF WATER & POWER	CONSUMER PROTECTION		LOS ANGELES, CA 90012
CITY ATTORNEY'S OFFICE	MICHAEL STANLEY	DEPARTMENT OF BUILDING & SAFETY	200 N. MAIN STREET, #1700	LOS ANGELES, CA 90012
CHIEF CONSERVAION BUREAU	MR. FRANK KROEGER	200 N. SPRING STREET	CITY HALL, ROOM 425	LOS ANGELES,, CA 90012
MAIN CITY HALL, ROOM 490	ROBERT ENGLAND	221 NO. FIGUEROA STREET,STE. 660		LOS ANGELES, CA 90012
PRINCIPAL EMERGENCY MGMT. & TRAINING DIV	DAVID KEIM	1111 WEST NINTH ST.		LOS ANGELES, CA 90012-2601
PLUMBERS & PIPE FITTERS LOCAL #78	ATTN: CALVIN EMERY	400 W. WASHINGTON BLVD.		LOS ANGELES, CA 90015
L.A. TRADE TECH	ATTN: PROFESSOR NANCY SPILLMAN			LOS ANGELES, CA 90015
LEAGUE OF CALIFORNIA CITIES	900 WILSHIRE BLVD., SUITE 702	700 S. FLOWER, SUITE 508		LOS ANGELES, CA 90017
BLDG. OWNERS & MGRS. ASSN. OF L. A.	ATTN: FRANK WAMBACH	900 WILSHIRE BLVD., SUITE 1400		LOS ANGELES, CA 90017
FORSTER, GEMILL & FARMER	ATTN: JOHN E. MC KENNA, JR.	P.O. BOX 17157, FOY STATION		LOS ANGELES, CA 90017
HOUSING AUTHORITY OF THE	CITY OF LOS ANGELES	401 SHATTO PLACE, SUITE 101		LOS ANGELES, CA 90017
SHT. METAL & AIR COND. CONTRACTORS ASSN.	ATTN: C. STEWART PERKINS	525 S. VIRGIL AVE.		LOS ANGELES, CA 90020
CA. ASSOCIATION OF REALTORS	LIBRARY	11000 WILSHIRE BLVD.		LOS ANGELES, CA 90020
V. A. OFFICE OF DISTRICT COUNSEL	ATTN: VINCE TITTLE, ATTORNEY (02A8)	11000 WILSHIRE BOULEVARD		LOS ANGELES, CA 90024
VA OFFICE OF DISTRICT COUNSEL	ATTN: VINCE TITTLE, ATTY. 02A6	1990 SOUTH BUNDY DRIVE		LOS ANGELES, CA 90024
DIRECTOR OF PRODUCTIVITY	NADEL PARTNERSHIP, INC.	1571 BEVERLY BOULEVARD		LOS ANGELES, CA 90025
BLDG. IND. ASSN. OF CALIF. INC	ATTN. GEORGE C. GALVIN	5151 STATE UNIVERSITY DRIVE		LOS ANGELES, CA 90026
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P.F.S. CORPORATION	ROBERT NELSON	9028 MONTE MAR		LOS ANGELES, CA 90034
LEAGUE OF WOMEN VOTERS	ATTN: INGRID MARKUL	BUILDING OFFICIAL	2535 COMMERCE WAY	LOS ANGELES, CA 90035
CITY OF COMMERCE	TOM REMILARD			COMMERCE, CA 90040
J.J. BLUMLENKRANZ	7312 WOODROW WILSON DRIVE	TERMINAL ANNEX P.O. BOX 3249		HOLLYWOOD, CA 90046
SOUTHERN CALIFORNIA GAS COMPANY	ATTN: MANUEL J. PARRA			LOS ANGELES, CA 90051

CALIFORNIA CONFERENCE OF MASON	CONTRACTORS ASSOCIATIONS INC.	2550 BEVERLY BLVD.		LOS ANGELES, CA 90057
STRUCTURAL ENGINEERS ASSOCIATION	OF SOUTHERN CALIFORNIA	2550 BEVERLY BLVD.		LOS ANGELES, CA 90057
CITY OF LOS ANGELES	SALVADOR JIMENEZ	HOUSING AUTHORITY	2500 WILSHIRE BLVD., 13TH FL. STE. 8	LOS ANGELES, CA 90057
CITY OF VERNON	VICTOR H VAITS	BUILDING OFFICIAL	4305 SANTA FE AVENUE	VERNON, CA 90058
THE ARCHITECTS STUDIO	ATTN: FARAJ	11237 PEARL ST.		W. LOS ANGELES, CA 90064
CITY OF WEST HOLLYWOOD	ROBERT M HARVEY	BUILDING OFFICIAL	8611 SANTA MONICA BOULEVARD	WEST HOLLYWOOD, CA 90069-4109
BANK OF AMERICA	APPRAISAL DEPT. #4370	11TH FLR., 555 S. FLOWER ST.		LOS ANGELES, CA 90071
HILL,FARRER & BURRILL	ATTN: BENJAMIN B. SALVATY	445 SO. FIGUEROA, 35TH FL.,UNION BANK SQ		LOS ANGELES, CA 90071
ATTORNEY AT LAW	RALPH M OCHA	444 S. FLOWER ST. #1800		LOS ANGELES, CA 90071-2901
UNIVERSITY OF SOUTHERN CALIFORNIA	DOHENY MEMORIAL LIBRARY	UNIVERSITY PARK MC-182		LOS ANGELES, CA 90089-0182
CITY OF BELL	ADOLFO RETEA	BUILDING DEPARTMENT	6330 PINE AVENUE	BELL, CA 90201
CITY OF CUDAHY	DAN PULONE	BUILDING DEPARTMENT	5220 SANTA ANA STREET	CUDAHY, CA 90201
CITY OF CUDAHY	DANIEL A PULONE	BUILDING OFFICIAL	P.O. BOX 1007	CUDAHY, CA 90201
CITY OF BELL GARDENS	JAMES GUERRA	BUILDING OFFICIAL	7100 SOUTH GARFIELD AVENUE	BELL GARDENS, CA 90201
CITY OF BELL	TED BALL	BUILDING OFFICIAL	6330 PINE AVENUE	BELL, CA 90201
CITY OF BEVERLY HILLS	RONALD B CLARK	BUILDING OFFICIAL	455 NORTH REXFORD DRIVE	BEVERLY HILLS, CA 90210
CITY OF COMPTON	WILLIAM L EDWARDS	BUILDING OFFICIAL	205 S. WILLOWBROOK AVE.	COMPTON, CA 90220
THE KNICKREHM COMPANY	ATTN: ALLEN F KNICKREHM	5185 KAREN CIRCLE		CULVER CITY, CA 90230-4906
CULVER CITY	ROCCO SERRATO	BUILDING OFFICIAL	P.O. BOX 507	CULVER CITY, CA 90232-0507
CITY OF DOWNEY	WILLIAM N MAKSHANOFF	BUILDING OFFICIAL	11111 BROOKSHIRE AVENUE	DOWNEY, CA 90241-7331
CITY OF EL SEGUNDO	HYRUM B FEDJE	BUILDING OFFICIAL	350 MAIN STREET	EL SEGUNDO, CA 90245
THE PEARSON GROUP	ATTN: JAMES F. MITCHELL	1555 WEST REDOND BEACH BLVD.		GARDENA, CA 90247
INDUSTRIAL POLYCHEMICAL SERVICE	ATTN: JIM MC BRIDE	P.O. BOX 379		GARDENA, CA 90247
CITY OF GARDENA	KATHY IKARI	BUILDING OFFICIAL	1700 WEST 162ND STREET	GARDENA, CA 90247
CITY OF GARDENIA	ROBERT McCOLUM	BLDG. & SAFETY	1700 W. 162ND STREET	GARDENIA, CA 90247
RTL, INC.	16421 AVALON BOULEVARD			GARDENA, CA 90248
CITY OF HAWTHORNE	DONALD J KNECHTEL	BUILDING OFFICIAL	4455 WEST 126TH STREET	HAWTHORNE, CA 90250
CITY OF HERMOSA BEACH	WILLIAM GROVE	BUILDING OFFICIAL	1315 VALLEY DRIVE	HERMOSA BEACH, CA 90254
CITY OF HUNTINGTON PARK	JAMES G FUNK	BUILDING OFFICIAL	6550 MILES AVENUE	HUNTINGTON PARK, CA 90255
CITY OF LAWNDALE	CABDIS FARMER	BUILDING OFFICIAL	14717 SOUTH BURIN AVENUE	LAWNDALE, CA 90260
CITY OF LYNWOOD	DAVID FINNEY	BUILDING OFFICIAL	13300 BULLIS ROAD	LYNWOOD, CA 90262
SR BLDG INSPECTOR & DIVISION MGR.	DAVID FINNEY	CITY OF LYNWOOD, BUILDING DEPARTMENT	11330 BULLIS ROAD	LYNWOOD, CA 90262
CITY OF MANHATTAN BEACH	MOHAMED B GANABA	BUILDING OFFICIAL	1400 HIGHLAND AVENUE	MANHATTAN BEACH, CA 90266-1040
CITY OF MAYWOOD	DAVID MANGO	BUILDING OFFICIAL	4319 EAST SLAUSON AVENUE	MAYWOOD, CA 90270
CITY OF RANCHO PALOS VERDES	DAVID J BAIRD	BUILDING OFFICIAL	30940 HAWTHORNE BOULEVARD	RANCHO PALOS VERDES, CA 90274
CITY OF PALOS VERDES ESTATES	GARRY WINN	BUILDING OFFICIAL	340 PALOS VERDES DR.	PALOS VERDES ESTATES, CA 90274-0283
AMERICAN SAVINGS & LOAN ASSN.	ATTN: BOB HARBOUR	1600 S. PACIFIC COAST HIGHWAY		REDONDO BEACH, CA 90277
CITY OF REDONDO BEACH	NAGY JACOB	BUILDING DEPARTMENT	P.O. BOX 270	REDONDO BEACH, CA 90277
CITY OF REDONDO BEACH	NAGY JACOBS	BUILDING OFFICIAL	PO BOX 270, 415 DIAMOND ST	REDONDO BEACH, CA 90277
SEAY DEVELOPMENT	8664 RHEEM AVENUE			SOUTH GATE, CA 90280
HIRATA ARCHITECTS	1732 W. WASHINGTON BLVD.			VENICE, CA 90291
CITY OF INGLEWOOD	JOSE ALVAREZ	BUILDING OFFICIAL	P.O. BOX 6500,1 MANCHESTER BLVD.	INGLEWOOD, CA 90301
JERRY JEFFE	815 N. LA BREA, SUI8TE 197			INGLEWOOD, CA 90302
JERRY JEFFE	815 N. LA BREA, SUITE 197			INGLEWOOD, CA 90302
GOVERNMENT CENTER	JERRY JEFFE	815 N. LA BREA, SUITE 197		INGLEWOOD, CA 90302
JOHANNA GUDICK	1685 MAIN STREET, ROOM 212			SANTA MONICA, CA 90401
THE LANDAU PARTNERSHIP, INC. A	RCHITECTS & PLANNERS	1520 SECOND STREET		SANTA MONICA, CA 90401
CITY OF SANTA MONICA	WILLIAM D ROME	BUILDING OFFICIAL	1685 MAIN STREET, ROOM 111	SANTA MONICA, CA 90401
PLUMBERS & PIPE FITTERS LOCAL #545	ATTN: JAMES NAUMANN	2439 SANTA MONICA BLVD.		SANTA MONICA, CA 90404
CARDE TEN ARCHITECTS	MAY LEE	1638 NINETEENTH STREET		SANTA MONICA, CA 90404
CITY OF TORRANCE	JIM ISHIMOTO	BUILDING OFFICIAL	3031 TORRANCE BOULEVARD	TORRANCE, CA 90503
INTERNATIONAL CONFERENCE OF	BUILDING OFFICIALS	5360 S. WORKMAN MILL ROAD		WHITTIER, CA 90601
INTERNATIONAL CONFERENCE OF	BUILDING OFFICIALS	5360 WORKMAN MILL RD.		WHITTIER, CA 90601
CITY OF WHITTIER	RICHARD HUBINGER	BUILDING OFFICIAL	13230 PENN STREET	WHITTIER, CA 90602
CITY OF BUENA PARK	LEE HITCHCOCK	BUILDING OFFICIAL	P.O. BOX 5009	BUENA PARK, CA 90622
CITY OF LA PALMA	PAUL D PITTS	BUILDING OFFICIAL	7822 WALKER STREET	LA PALMA, CA 90623
CITY OF CYPRESS	LINDA HAINES	BUILDING DEPARTMENT	5275 ORANGE AVENUE	CYPRESS, CA 90630
CITY OF CYPRESS	LINDA HAINES	BUILDING OFFICIAL	5275 ORANGE AVENUE	CYPRESS, CA 90630
CITY OF LA HABRA HEIGHTS	BILL FLOWER	BUILDING OFFICIAL	1245 NORTH HACIENDA BOULEVARD	LA HABRA HEIGHTS, CA 90631
CITY OF LA HABRA BLDG. DEPT.	RICHARD WOODS	ATTN: RICHARD WOODS	201 E. LA HABRA BL., CIVIC CTR	LA HABRA, CA 90631
CITY OF LA HABRA	RICHARD WOODS	BUILDING OFFICIAL	901 EAST LA HABRA BLVD.	LA HABRA, CA 90631
CITY OF LA MIRADA	GILBERT GONZALES	BUILDING OFFICIAL	13700 SOUTH LA MIRADA	LA MIRADA, CA 90638
CITY OF MONTEBELLO	JOEL RANDALL	BUILDING OFFICIAL	1600 WEST BEVERLY BOULEVARD	MONTEBELLO, CA 90640
CITY OF NORWALK	DUANE TAYLOR	BUILDING OFFICIAL	12700 SOUTH NORWALK BOULEVARD	NORWALK, CA 90650
CITY OF NORWALK	DWAYNE TAYLOR	BUILDING DEPARTMENT	12700 S. NORWALK BOULEVARD, ROOM 11	NORWALK, CA 90650
CITY OF PICO RIVERA	DAVID HERTZING	BUILDING OFFICIAL	6615 PASS ON BOULEVARD	PICO RIVERA, CA 90660
CITY OF SANTA FE SPRINGS	LARRY AMMON	BUILDING OFFICIAL	11710 TELEGRAPH RD.	SANTA FE SPRINGS, CA 90670
SMCNA	ATTN: C.S. PERKINS	12070 TELEGRAPH RD. STE. 350		SANTE FE SPRINGS, CA 90670-3746
SERVICE PLUMBING	ATTN: ROBERT QUAST	7600 INDUSTRIAL		STANTON, CA 90680
CITY OF SOUTH GATE	CHON CERVANTES	BUILDING OFFICIAL	8650 CALIFORNIA AVENUE	SOUTH GATE, CA 90680
CITY OF STANTON	PHIL RAMOS	BUILDING OFFICIAL	7800 KATELLA AVE.	STANTON, CA 90680
CITY OF CERRITOS	BILL MAKSHANOFF	BUILDING OFFICIAL	18125 BLOOMFIELD AVENUE	CERRITOS, CA 90701
CITY OF ARTESIA	RYONT HONG	BUILDING OFFICIAL	18747 CLARKDALE AVE.	ARTESIA, CA 90701
CITY OF AVALON	THOMAS C DAVIS	BUILDING OFFICIAL	P.O. BOX 707	AVALON, CA 90704

CITY OF BELLFLOWER	CRAIG MELICHER	BUILDING OFFICIAL	16600 CIVIC CENTER DR.	BELLFLOWER, CA 90706
CITY OF LAKEWOOD	DEL LAMPE	BUILDING OFFICIAL	5050 CLARK AVENUE	LAKEWOOD, CA 90712
CITY OF HAWAIIAN GARDENS	ATTN: THERESA DOBBS REHAB SPECIALIST	21815 S. PIONEER BLVD.		HAWAIIN GARDENS, CA 90716
CITY OF HAWAIIAN GARDENS	BUILDING OFFICIAL	21815 PIONEER BLVD.		HAWAIIAN GARDENS, CA 90716
CITY OF LOMITA	LATA THAKAR	BUILDING OFFICIAL	24320 SOUTH NARBONNE AVENUE	LOMITA, CA 90717
CITY OF ROLLING HILLS	LATA THAKER	BUILDING OFFICIAL	24320 S. NARBONNE AVE.	LOMITA, CA 90717
CITY OF ROLLING HILLS ESTATES	LATA THAKER	BUILDING OFFICIAL	24320 SOUTH NARBONNE AVENUE	LOMITA, CA 90717
ARMED FORCES RESERVE CENTER	ATTN: DIR. FACILITIES & ENG.	BUILDING 35		LOS ALAMITOS, CA 90720
CITY OF LOS ALAMITOS	JERRY ANDERSON	BUILDING DEPARTMENT	3191 KATELLA AVENUE OR P.O. BOX 3147	LOS ALAMITOS, CA 90720-0347
CITY OF LOS ALAMITOS	VERN HEE	BUILDING OFFICIAL	3191 KATELLA AVENUE	LOS ALAMITOS, CA 90720-0347
RAMTECH LABORATORIES	14104 ORANGE AVENUE			PARAMOUNT, CA 90723
INSPECTION CONCEPTS	14108 ORANGE AVENUE			PARAMOUNT, CA 90723
RON OGAWA	14108 ORANGE AVENUE			PARAMOUNT, CA 90723
INSPECTION CONCEPTS	RONALD OGAWA	14108 ORANGE AVE.		PARAMOUNT, CA 90723
KENNETH DARLING, AIA	FISHERMAN'S WHARF, BERTH #73			SAN PEDRO, CA 90731
CITY OF SEAL BEACH	LEE BAUCKE	BUILDING OFFICIAL	211 EIGHTH STREET, CITY HALL	SEAL BEACH, CA 90740
RUBEN N FLORES	P.O BOX 2746			SEAL BEACH, CA 90740
CITY OF CARSON	PAT BROWN	BUILDING DEPARTMENT	701 E. CARSON STREET	CARSON, CA 90745
CITY OF CARSON	PATRICK BROWN	BUILDING OFFICIAL	701 EAST CARSON STREET	CARSON, CA 90745
LONG BEACH DEPT OF PLANNING	ATTN: J.G. OSUNA	333 W. OCEAN BLVD., 4TH FLOOR		LONG BEACH, CA 90802
CITY OF LONG BEACH	EUGENE J ZELLER	BUILDING OFFICIAL	333 WEST OCEAN BOULEVARD	LONG BEACH, CA 90802
DEPT. OF PLANNIN & BUILDING	J. G. OSUNA	333 OCEAN BLVD. 4TH FLOOR		LONG BEACH, CA 90802
HOUSING REHAB SUPERIOR	MR. DWAIN LIGGETT	DEPT. OF COMMUNITY DEVELOPMENBT	333 OCEAN BLVD.	LONG BEACH, CA 90802
RADCO, INC.	3220 E. 59TH STREET			LONG BEACH, CA 90805
RADCO	CORPORATE OFFICES	3220 E. 59TH ST.		LONG BEACH, CA 90805
CITY OF SIGNAL HILL	GARY JONES	BUILDING OFFICIAL	2175 CHERRY AVENUE	SIGNAL HILL, CA 90806
DIRECTOR BUILDING AND SAFETY	WILLIAM WESTBY	CITY OF SIGNAL HILL	2175 CHERRY AVE.	SIGNAL HILL, CA 90806
PLUMBERS & PIPE FITTERS LOCAL #494	ATTN: W. J. GEIGER	1246 LOCUST AVE.		LONG BEACH, CA 90813
PLMBRS & PIPEFITTERS LOCAL 494	ATTN: W. J. GEIGER	1246 LOCUST AVENUE		LONG BEACH, CA 90813
TEMPLE CITY	LARRY AMMON	BUILDING OFFICIAL	125 SOUTH BALDWIN	ARCADIA, CA 91006
CITY OF ARCADIA	GREG GERLACH	BUILDING OFFICIAL	240 WEST HUNTINGTON DRIVE	ARCADIA, CA 91007
CITY OF DURATE	DOMINIC C MIANO	BUILDING OFFICIAL	1600 EAST HUNTINGTON DRIVE	DUARTE, CA 91010
CITY OF BRADBURY	MERLE FREDRICKSON	BUILDING OFFICIAL	600 WINSTON AVENUE	BRADBURY, CA 91010
CITY OF LA CANADA-FLINTRIDGE	WILLIAM CAMPBELL	BUILDING OFFICIAL	1327 FOOTHILL BOULEVARD	LA CANADA, CA 91011
CITY OF MONROVIA	PAUL SHEEDY	BUILDING OFFICIAL	415 SOUTH IVY AVENUE	MONROVIA, CA 91016
CITY OF SIERRA MADRE	STEVE POCK	BUILDING OFFICIAL	232 WEST SIERRA MADRE BOULEVARD	SIERRA MADRE, CA 91024
CITY OF SOUTH PASADENA	JOE RANDALL	BUILDING OFFICIAL	1414 MISSION STREET	SOUTH PASADENA, CA 91030
LAND DESIGN CONSULTANTS, INC.	201 S. LAKE AVE. SUITE 500			PASADENA, CA 91101
JAMES SPEHALSKI	2698 MATARO STREET			PASADENA, CA 91107
CITY OF SAN MARINO	DENNIS A TARÁNGO	BUILDING OFFICIAL	2200 HUNTINGTON DRIVE	SAN MARINO, CA 91108
CITY OF PASADENA	RODERICK OLGUIN	BUILDING OFFICIAL	HALE BLDG. 100 N. GARFIELD AVE.	PASADENA, CA 91109
AFFIRMATIVE ACTION DEPARTMENT	ROBERT GORSKI	100 NORTH GARFIELD, ROOM 321		PASADENA, CA 91109-7215
INSTITUTE OF HEATING & AIR	CONDITIONING INDUSTRIES, INC.	454 W. BROADWAY		GLENDALE, CA 91204
S&S PLUMBING COMPANY	MR. SOORIK	343 W. CYPRESS AVENUE		GLENDALE, CA 91204
CITY OF GLENDALE	SAM R GOOD	BUILDING OFFICIAL	633 EAST BROADWAY, ROOM 101	GLENDALE, CA 91206-4390
LEE ARCHER	3402 COMMUNITY AVE.			LA CRESCENTA, CA 91214
CITY OF AGOURA HILLS	TONY FALCONE	BUILDING OFFICIAL	30101 AUGORA COURT, SUITE 102	AGOURA HILLS, CA 91301
CITY OF HIDDEN HILLS	ELIZABETH WARD-McCANN	BUILDING OFFICIAL	6165 SPRING VALLEY ROAD	HIDDEN HILLS, CA 91302
LOS VIRGINES MUNICIPAL WATER DISTRICT	JIM GRAHAM	4232 LOS VIRGINES ROAD		CALABASSAS, CA 91302
CITY OF WESTLAKE VILLAGE	JAMES SAFARIK	BUILDING OFFICIAL	4111 N. LAS VIRGENES RD.	CALABASAS, CA 91302-1929
CITY OF THOUSAND OAKS	JIM WOOD	BUILDING AND SAFETY DEPARTMENT	2150 WEST HILLCREST DRIVE	THOUSAND OAKS, CA 91320
RON MODUGNO	27781 AVENUE HOPKINS			VALENCIA, CA 91335
CITY OF SAN FERNANDO	NORMAN CONCHEOLA	BUILDING OFFICIAL	117 MAC NEIL STREET	SAN FERNANDO, CA 91340
WALTER ABRANSON	17037 LIFETTE STREET			GRANADA HILLS, CA 91344
AMERICAN SOCIETY OF PLUMBING	3617 THOUSAND OAKS BLVD, STE. 210			WESTLAKE VILLAGE, CA 91362
CALLEGUS WATER DISTRICT	ERIC BERGH	2100 OLSEN		THOUSAND OAKS, CA 91362
CITY OF THOUSAND OAKS	DAVID A HUENERS	BUILDING OFFICIAL	2100 E.THOUSAND OAKS BLVD	THOUSAND OAKS, CA 91362-2999
AUGUST BACCHETTA, ARCHITECT	350 NORTH GLENOAKS BLVD AUITE 301			BURBANK, CA 91502
CITY OF BURBANK	JOHN CHANG	BUILDING OFFICIAL	275 EAST OLIVE AVENUE	BURBANK, CA 91502
E. I. DUPONT & COMPANY	3300 PACIFIC AVENUE			W. BURBANK, CA 91505
E.I. DU PONT & COMPANY	3300 PACIFIC AVENUE			W. BURBANK, CA 91505
PLUMBERS & PIPEFITTERS	ATTN: FRED E. WEEKS, LOCAL 761	1305 NORTH NIAGARA STREET		BURBANK,, CA 91505
PLUMBERS LOCAL #761	DON ARNOLD	1305 N. NIAGARA		BURBANK, CA 91505
PLUMBERS & PIPE FITTERS LOCAL #761	ATTN: STUART NAISMITH	1305 N. NIAGARA ST.		BURBANK, CA 91505-1999
CITY OF BURBANK	BRUCE FENG	BUILDING DEPARTMENT	P.O. BOX 6459	BURBANK, CA 91510
CITY OF IRWINDALE	FRANKLIN D HARRIS	BUILDING OFFICIAL	5050 NORTH IRWINDALE AVENUE	IRWINDALE, CA 91706
CITY OF BALDWIN PARK	RAYMOND COSGROVE	BUILDING DEPARTMENT	14403 E. PACIFIC AVENUE	BALDWIN PARK, CA 91706
CITY OF BALDWIN PARK	RICK FORINTOS	BUILDING OFFICIAL	14403 EAST PACIFIC AVENUE	BALDWIN PARK, CA 91706
'T' MC GEE ELECTRIC, INC.	P.O. BOX 1111			CHINO, CA 91708
CITY OF CHINO	ROBERT J WERNER	BUILDING OFFICIAL	13220 CENTRAL AVENUE	CHINO, CA 91710
PLUMBERS & PIPE FITTERS LOCAL #398	ATTN: JAMES HURST	170 W. SAN JOSE ST., RM. 108		CLAREMONT, CA 91711
CITY OF CLAREMONT	DUANE A MARKS	BUILDING OFFICIAL	P.O. BOX 880	CLAREMONT, CA 91711-0880
CMJ ENGINEERING, INC.	1450 WEST SIXTH STREET, SUITE 202			CORONA, CA 91720
SILVERCREST INDUSTRIES, INC.	299 N. SMITH AVENUE			CORONA, CA 91720

CITY OF CORONA	KEITH CLARKE	BUILDING OFFICIAL	815 W. SIXTH STREET	CORONA, CA 91720-0090
BARNARD CHEMICAL CO., INC.	P.O. BOX 1105			COVINA, CA 91722
BERNARD CHEMICAL CO., INC.	P.O. BOX 1105			COVINA, CA 91722
CITY OF COVINA	MILTON MASSANET	BUILDING OFFICIAL	125 EAST COLLEGE STREET	COVINA, CA 91723-2199
COMMUNITY DEV SERVICES, INC.	ATTN: THOMAS BALDERRAMA	520 SHOUSE AVENUE		COVINA, CA 91724
MUNICIPAL SERVICE CONSULTANT	THOMAS BALDERRAMA	520 SHOUSE AVENUE		COVINA, CA 91724
CITY OF RANCHO CUCAMONGA	JERRY R GRANT	BUILDING OFFICIAL	PO BOX 807	RANCHO CUCAMONGA, CA 91729
DON WOOD	10040 FOOTHILL BLVD.			RANCHO CUCAMONGA, CA 91730
WOOD ENGINEERING	10040 FOOTHILL BOULEVARD			RANCHO CUCAMONGA, CA 91730
TRU-LOCK METAL FABRICATING CO.	9444 - 9TH STREET			CUCAMONGA, CA 91730
MANUFACTURED HOUSING INSTITUTE	JESS MAXCY	10630 TOWN CENTER DRIVE, SUITE 120		RANCHO CUCAMUNGA, CA 91730
POWER SYSTEM DYNAMICS	JOHN F SHANAHAN	8837 GROVE AVENUE, #813		RANCHO CUCAMONGA, CA 91730
COMMUNITY DEVELOPMENT DEPT.	ATTN: RALPH R. ESPARZA	11333 E. VALLEY BLVD.		E. MONTE, CA 91731
CITY OF EL MONTE	JERRY MAIQUES	BUILDING OFFICIAL	CITY HALL, 11333 E. VALLEY BLVD	EL MONTE, CA 91731
HOUSING ENFORCEMENT OFFICER	RALPH NUNEZ	CITY OF EL MONTE	11333 E. VALLEY BLVD., CITY HALL WEST	EL MONTE, CA 91731
CITY OF SOUTH EL MONTE	JERRY MAIQUES	BUILDING OFFICIAL	1415 N. SANTA ANA AVE.	SO. EL MONTE, CA 91733
PAULSON ENGINEERING	112 W. BENNET, SUITE 9			GLENDORA, CA 91740
CITY OF GLENDORA	CHRIS PRENTICE	BUILDING OFFICIAL	116 EAST FOOTHILL BOULEVARD	GLENDORA, CA 91740
CITY OF LA PUENTE	DON MARTIN	BUILDING OFFICIAL	16005 EAST CENTRAL AVENUE	LA PUENTE, CA 91744
CITY OF INDUSTRY	LARRY AMMON	BUILDING OFFICIAL	16005 EAST CENTRAL AVENUE	LA PUENTE, CA 91744
WILLDAN ASSOCIATES	ATTN: JOHN MAULDING	12900 CROSSROADS PARKWAY SOUTH SUITE 200		INDUSTRY, CA 91746
CRANE/PLUMBING, INC.	P.O. BOX 1273			CITY OF INDUSTRY, CA 91749
CITY OF LA VERNE	JACK FOYE	BUILDING OFFICIAL	3660 D STREET	LOS ANGELES, CA 91750
PAUL SCHNURIGER	320 WEST NEWMARK AVE.			MONTEREY PARK, CA 91754
COUNTY OF LOS ANGELES-ENV. HEALTH	MANAGER, PROGRAM PLANNING	2525 CORPORATE PL., SUITE 150		MONTEREY PARK, CA 91754
CITY OF MONTEREY PARK	YUNG-CHENG KAO	BUILDING OFFICIAL	320 WEST NEWMARK AVENUE	MONTEREY PARK, CA 91754
CITY OF NORCO	JAMES THOMAS	BUILDING OFFICIAL	2870 CLARK AVE.	NORCO, CA 91760
INSCO MODULAR STRUCTURES	1516 BON VIEW			ONTARIO, CA 91761
WESTWAY HOMES, INC.	P.O. BOX 3850			ONTARIO, CA 91761
STANDARD PACIFIC INDUSTRIES	P.O. BOX 2058			MONTCLAIR, CA 91763
CITY OF MONTCLAIR	STEVE GRIGGS	BUILDING OFFICIAL	5111 BENITO STREET	MONTCLAIR, CA 91763
CITY OF ONTARIO	KENNETH GILMAK	BUILDING OFFICIAL	303 EAST B STREET	ONTARIO, CA 91764
CITY OF POMONA	SIMON SHOO	BUILDING OFFICIAL	505 SOUTH GARY AVE	POMONA, CA 91766
CITY OF POMONA	SIMON SHOO	DEPT. OF BUILDING & SAFETY	505 S GARY AVE	POMONA, CA 91766
SOUTHERN CALIFORNIA EDISON CO.	ATTN: R. B. SINGER	P.O. BOX 800		ROSEMEAD, CA 91770
CITY OF ROSEMEAD	JAMES GUERRA	BUILDING OFFICIAL	P.O. BOX 399	ROSEMEAD, CA 91770
CITY OF SAN DIMAS	RAY MONTGOMERY	BUILDING OFFICIAL	PO BOX 307, 245 E. BONITA AVE.	SAN DIMAS, CA 91773
CITY OF SAN GABRIEL	DWIGHT FRENCH	BUILDING OFFICIAL	P.O. BOX 130, 532 W. MISSION DR.	SAN GABRIEL, CA 91778-0130
CITY OF UPLAND	DON RAMSEY	BUILDING OFFICIAL	460 NORTH EUCLID AVE., PO BOX 460	UPLAND, CA 91785
NATIONAL SANITATION FOUNDATION	ATTN: R. HURD	521 N. MOUNTAIN AVE., SUITE J		UPLAND, CA 91786
IAPMO	ED WACHTER	EXECUTIVE DIRECTOR	20001 S. WALNUT DRIVE	WALNUT, CA 91789
CITY OF WALNUT	RON KRANZER	BUILDING OFFICIAL	PO BOX 682, 21201 LA PUENTE ROAD	WALNUT, CA 91789
IAPMO	DONALD LAUFLIN	20001 WALNUT DRIVE SOUTH		WALNUT, CA 91789-2825
INTERNATIONAL ASSOCIATION OF	KENNETH KOCHMANN	PLUMBING & MECH. OFFICIALS	20001 WALNUT DRIVE SO.	WALNUT, CA 91789-2825
CITY OF WEST COVINA	SHANNON YAUCHZEE	BUILDING OFFICIAL	PO BOX 1440, 1444 W. GARVEY AVE.	WEST COVINA, CA 91793
CITY OF ALHAMBRA	CRAIG MELICHER	BUILDING OFFICIAL	111 SOUTH FIRST STREET	ALHAMBRA, CA 91801
CHIN LLEWELLYN	1717 PEDLEY DR.			ALHAMBRA, CA 91803
DEPT. OF PUBLIC WORKS, BLDG. & SAFETY	JIM FRY	900 SOUTH FREEMONT AVE.		ALHAMBRA, CA 91803
COUNTY OF LOS ANGELES	JOHN KELLY	BUILDING OFFICIAL	900 S. FREMONT AVENUE, 3RD FLOOR	ALHAMBRA, CA 91803
CITY OF CHULA VISTA, BUILDING DEPT.	246 4TH AVENUE			CHULA VISTA, CA 91910
CITY OF CHULA VISTA	DICK FOSTER	BUILDING DEPARTMENT	276 4TH AVENUE	CHULA VISTA, CA 91910
THE ASSOC. GROUP FOR AFFORDABLE HOUSING	8085 LA MESA BOULEVARD, SUITE 210			LA MESA, CA 91941
CITY OF LA MESA	JESSIE WU	BUILDING DIRECTOR	P.O. BOX 937, 8130 ALLISON AVE	LA MESA, CA 91941
CITY OF CARLSBAD	PAT KELLY	BUILDING OFFICIAL	2075 LAS PALMAS	CARLSBAD, CA 92009
CITY OF CHULA VISTA	BRAD REMP	BUILDING OFFICIAL	276 FOURTH AVENUE	CHULA VISTA, CA 92010
CITY OF DEL MAR	BUILDING & SAFETY	1050 CAMINO DEL MAR		DEL MAR, CA 92014
CITY OF DEL MAR	WM HEALY	BUILDING OFFICIAL	1050 CAMINO DEL MAR	DEL MAR, CA 92014
CITY OF EL CAJON	DON MEADOWS	BUILDING DEPARTMENT	200 E. MAIN - 3RD FLOOR	EL CAJON, CA 92020
CITY OF EL CAJON	WILLIAM 'BILL' L CARROLL	BUILDING OFFICIAL	200 EAST MAIN - 3RD FLOOR	EL CAJON, CA 92020
COPPER DEVELOPMENT ASSOCIATION INC.	ATTN: JIM WEFLEN	P.O. BOX 234066		ENCINITAS, CA 92023-4066
CITY OF ENCINITAS	CHUCK MENDENHALL	BUILDING OFFICIAL	505 S. VULCAN AVENUE	ENCINITAS, CA 92024-3633
CITY OF ESCONDIDO	MICHAEL HARRINGTON	BUILDING DEPARTMENT	201 NORTH BROADWAY	ESCONDIDO, CA 92025
CITY OF ESCONDIDO	CHARLES GRIMM	BUILDING OFFICIAL	201 N. BROADWAY	ESCONDIDO, CA 92025-2798
CARL CLINE	525-114 W. EL NORTE PARKWAY			ESCONDIDO, CA 92026
DENNIS RECKER	1702 SANTA MARGARITA DR.			FALLBROOK, CA 92028
CITY OF IMPERIAL BEACH	ROBERT GHILONI	825 IMPERIAL BEACH BOULEVARD		IMPERIAL BEACH, CA 92032
MW STEELE AND ASSOC.	RANDY HANNA	7881 DRURY LANE		LA JOLLA, CA 92037
CITY OF LA MESA	JESSIE Y WU	BUILDING OFFICIAL	ADMIN. BLDG., 8130 ALLISON AVENUE	LA MESA, CA 92041
CHIEF BUILDING INSPECTOR	ALFRED LYNN	3232 MAIN STREET		LEMON GROVE, CA 92045
CITY OF LEMON GROVE	EDWARD B WILCZAK	BUILDING OFFICIAL	3232 MAIN STREET	LEMON GROVE, CA 92045
CITY OF NATIONAL CITY	MICHAEL W BOUSE	BUILDING OFFICIAL	1243 NATIONAL CITY BOULEVARD	NATIONAL CITY, CA 92050
OCEANSIDE BUILDING DEPT.	DOUG MORRIS	300 N COAST HWY.		OCEANSIDE, CA 92054
CITY OF OCEANSIDE	GREG ANDERSON	BUILDING OFFICIAL	300 NORTH HILL STREET	OCEANSIDE, CA 92054
CITY OF POWAY	RICHARD ESGATE	BUILDING OFFICIAL	13202 POWAY ROAD	POWAY, CA 92064

CASITAS DEL AMIGOS M.H.P.	RONALD STINEBISER	1195 LA MOREE ROAD SPACE #112		SAN MARCOS, CA 92069
CITY OF SAN MARCOS	CARL A BLAISDELL	BUILDING OFFICIAL	1 CIVIC CENTER DR.	SAN MARCOS, CA 92069-2949
CITY OF SANTEE	DICK ESGATE	BUILDING OFFICIAL	10601 MAGNOLIA AVE.	SANTEE, CA 92071-1264
CITY OF VISTA	MARK BEAUCHAMP	BUILDING OFFICIAL	600 EUCALYPTUS AVENUE	VISTA, CA 92085
CITY OF SAN DIEGO	ALI FATTAH	PLAN CHECK ENGINEER	1222 1ST AVE	SAN DIEGO, CA 92101
SAN DIEGO FIRE DEPARTMENT	ATTN: CAPTAIN R.G. DARRAH	1222 FIRST AVE.		SAN DIEGO, CA 92101
CA FIRE CHEIFS ASSN.	BILL TOMES	SAN DIEGO FIRE DEPT.	1222 FIRST AVE.	SAN DIEGO, CA 92101
CITY OF SAN DIEGO	RES. ENGINEER BRONSON RIDEOUT	BUILDING INSPECTION DEPT.	1222 - 1ST AVE., ML. STN.301	SAN DIEGO, CA 92101-4153
DEPUTY DIRECTOR	HOUSING & CODE ENFORCEMENT DIVISION	1222 FIRST AVENUE, MS 403		SAN DIEGO, CA 92101-4154
CITY OF SAN DIEGO BLDG. INSP.	HOUSING INSPECTION DIVISION	1010 -2ND AVENUE, SUITE 300		SAN DIEGO, CA 92101-4902
SUPERINTENDENT OF BUILDINGS	ALEXANDER PYPER	PUBLIC WORKS DIVISION	633 E. BROADWAY, ROOM 101	GLENDALE, CA 92106
ARCHITECTURAL BARRIERS BOARD	ONE ASHBURTON PLACE, ROOM 1319			BOSTON, MA 92108
BRUCE BENNETT	1504 REED AVENUE			SAN DIEGO, CA 92109
BOB HOLDERER	4777 RUFFNER STREET			SAN DIEGO, CA 92111
JOHN S CLARK	7920 ENGINEER RD.			SAN DIEGO, CA 92111
SAN DIEGO GAS & ELECTRIC CO.	P.O. BOX 1831, 101 ASH STREET			SAN DIEGO, CA 92112
ZAGRODNIK & THOMAS	JEANNE M ZAGRODNIK	5082 HAWLEY BLVD.		SAN DIEGO, CA 92118
CITY OF CORONADO	DONALD C ELBERT	BUILDING OFFICIAL	1845 STRAND WAY	CORONADO, CA 92118
CITY OF SAN DIEGO	ART BUXBAUM	9601 RIDGEHAVEN CT, RM 220		SAN DIEGO, CA 92123
ESGIL CORPORATION	ATTN: JAMES J. GILSHIAN	9320 CHESAPEAKE, SUITE 122		SAN DIEGO, CA 92123
BUILDING OFFICIAL	BILL HEALY	SAN DIEGO, DEPT. OF PLANNING & LAND USE	5201 RUFFIN ROAD, SUITE B	SAN DIEGO, CA 92123
ATTN: HOUING COORDINATOR	CO. OF SAN DIEGO	DEPT. OF PLANNING AND LAND USE	5201 RUFFIN ROAD, MS 0650	SAN DIEGO, CA 92123
COUNTY OF SAN DIEGO	IVAN HOLLER	BUILDING OFFICIAL	5201 RUFFIN ROAD, SUITE B	SAN DIEGO, CA 92123
DEPT. OF PLANNING & LAND USE	SHEILA CHAFFIN	COUNTY OF SAN DIEGO	5201 RUFFIN RD., STE. B	SAN DIEGO, CA 92123
BUILDING OFFICIAL	BUILDING OFFICIAL	5201 RUFFIN RD., SUITE C		SAN DIEGO, CA 92123-1666
DARREL ROSE	10240 RANCHO CARMEL			SAN DIEGO, CA 92128
PRATER & ASSOCIATES	KENT PRATER	12776 JORDAN RIDGE CT.		SAN DIEGO, CA 92130-2747
VISTA DE ORO	CONRAD SLABBERT	P.O. BOX 9483		SAN DIEGO, CA 92169
RIVERSIDE CO. DEPT. PUB. HLTH.	ATTN: GEORGE P. HOLK, R.S.	46209 OASIS STREET, ROOM 207		INDIO, CA 92201
RIVERSIDE CO. DEPT. PUB. HLTH.	ATTN: MICHAEL GARCIA, R.S.	46209 OASIS STREET, ROOM 207		INDIO, CA 92201
CITY OF INDIO	DERRICK KLEIMAN	BUILDING DEPARTMENT	P.O. DRAWER 1788	INDIO, CA 92202
CITY OF INDIO	DERRICK KLEIMAN	BUILDING OFFICIAL	P.O. DRAWER 1788	INDIO, CA 92202
CITY OF BANNING	BUILDING DEPARTMENT	98 E. RAMSEY		BANNING, CA 92220
CITY OF BANNING	TIM STENNSON	BUILDING OFFICIAL	P.O. BOX 998	BANNING, CA 92220
CITY OF BEAUMONT	ERNIE EGGER	BUILDING OFFICIAL	550 EAST SIXTH STREET	BEAUMONT, CA 92223
CITY OF BLYTHE	ROBERT CASIAS	BUILDING OFFICIAL	235 NORTH BROADWAY	BLYTHE, CA 92225
CITY OF BRAWLEY	FRANCISCO SOTO	BUILDING OFFICIAL	400 MAIN ST.	BRAWLEY, CA 92227
CITY OF CALEXICO	ROBERT WILLIAMS	BUILDING OFFICIAL	608 HEBER AVENUE	CALEXICO, CA 92231
CITY OF CALIPATRIA	JURG HEUBERGER	BUILDING OFFICIAL	101 NORTH LAKE STREET	CALIPATRIA, CA 92233
BUILDING OFFICIAL	TRAVIS LUND	CATHEDRAL CITY BUILDING DEPARTMENT	68-625 PEREZ ROAD/PO BOX 5001	CATHEDRAL CITY, CA 92235-5001
CITY OF COACHELLA	PAT GRANDALOS	BUILDING DEPARTMENT	1515 - 6TH STREET	COACHELLA, CA 92236
CITY OF CATHEDRAL CITY	TRAVIS R LUND	BUILDING OFFICIAL	68700 AVENIDA LALO GUERRERO	CATHEDRAL CITY, CA 92236
CITY OF COACHELLA	VICTOR RUIC	BUILDING OFFICIAL	1515 6TH STREET	COACHELLA, CA 92236
CITY OF DESERT HOT SPRINGS	JOHN MORGAN	BUILDING OFFICIAL	65950 PIERSON BOULEVARD	DESERT HOT SPRINGS, CA 92240-3006
CITY OF EL CENTRO	DEAN DAVIDSON	BUILDING OFFICIAL	1275 MAIN STREET	EL CENTRO, CA 92243
COUNTY OF IMPERIAL	JURG HEUBERGER	BUILDING OFFICIAL	939 MAIN STREET, SUITE B-1	EL CENTRO, CA 92243
IMPERIAL COUNTY, CITY OF BRAWLEY	MARCUS S TAPIA	BUILDING DEPARTMENT	939 MAIN STREET	EL CENTRO, CA 92243
IMPERIAL COUNTY	MARCUS S TAPIA	CITY OF EL CENTRO BUILDING DEPARTMENT	939 MAIN STREET	EL CENTRO, CA 92243
BUILDING INSPECTOR & MHP CO-ORDINATOR	MARCUS S TAPIA	IMPERIAL CO., BUILDING DEPARTMENT	939 MAIN STREET	EL CENTRO, CA 92243
CITY OF HOLTVILLE	LARRY MAKER	BUILDING OFFICIAL	CITY HALL, 121 WEST FIFTH STREET	HOLTVILLE, CA 92250-1298
CITY OF IMPERIAL	JURG HEUBERGER	BUILDING OFFICIAL	420 SOUTH IMPERIAL AVENUE	IMPERIAL, CA 92251
MC PHEETERS CONSULTING SERV., INC.	JERRY MC PHEETERS	PRESIDENT	63424 E. TILFORD WAY	JOSHUA TREE, CA 92252
CITY OF LA QUINTA	TOM HARTUNG	BUILDING OFFICIAL	P.O. BOX 1504	LA QUINTA, CA 92253
CITY OF PALM DESERT	PATRICK CONLON	BUILDING OFFICIAL	73-510 FRED WARING DR.	PALM DESERT, CA 92260
CITY OF INDIAN WELLS	BILL GORDON	BUILDING OFFICIAL	44-950 ELDORADO DRIVE	INDIAN WELLS, CA 92260-7407
CITY OF PALM SPRINGS	GARY BITTERMAN	BUILDING OFFICIAL	PO BOX 2743	PALM SPRINGS, CA 92263-2743
CITY OF PALM SPRINGS	JOHN SHUMAKER	DEPT. OF BUILDING AND SAFETY	P.O. BOX 2743	PALM SPRINGS, CA 92263-2743
CITY OF RANCHO MIRAGE	DICK TURRULL	BUILDING OFFICIAL	69-825 HIGHWAY 111	RANCHO MIRAGE, CA 92270
CITY OF RANCHO MIRAGE	PAUL FRANCKO	BUILDING DEPARTMENT	69-825 HIGHWAY 111	RANCHO MIRAGE, CA 92270
CITY OF WESTMORLAND	FRANK SOTO	BUILDING OFFICIAL	PO BOX 689, 355 S. CENTER ST.	WESTMORLAND, CA 92281
PLUMBERS & PIPE FITTERS LOCAL # 230	ATTN: KENNETH PAULSON	3909 CENTRE STREET.		SAN DIEGO, CA 92301
CITY OF ADELANTO	TOM FERRIS	BUILDING OFFICIAL	P.O. BOX 10	ADELANTO, CA 92301
CITY OF BARSTOW	MARLOWE E KULSETH	BUILDING OFFICIAL	220 EAST MOUNTAIN VIEW, SUITE A	BARSTOW, CA 92311
CITY OF GRAND TERRACE	VIRGIL BARHAM	BUILDING OFFICIAL	22795 BARTON RD., SUITE B	GRAND TERRACE, CA 92313
CITY OF GRANDE TERRACE	VIRGIL BARHAM	BUILDING OFFICIAL	22795 BARTON RD., SUITE B	GRANDE TERRACE, CA 92313
CITY OF BIG BEAR LAKE	DAVID MARTINEZ	BUILDING OFFICIAL	P.O. BOX 10000	BIG BEAR LAKE, CA 92315
CITY OF CALIMESA	DALE EVERMAN	BUILDING OFFICIAL	P.O. BOX 1190	CALIMESA, CA 92320
MERRIMAN'S INC.	DENNIS MERRIMAN	P.O. BOX 546		CALIMEXA, CA 92320
WILLIAMS-THE COMFORT PRODUCTS PEOPLE	ATTN: GARRY MC COPTIN	225 ACACIA STREET		COLTON, CA 92324
PLUMBERS & PIPE FITTERS LOCAL 364	ATTN: RONALD EDWARDS	223 S. RANCHO AVE.		COLTON, CA 92324
CITY OF COLTON	JAIME AGUILERA	BUILDING OFFICIAL	650 NORTH LA CADENA DR.	COLTON, CA 92324
C & R PIER MANUFACTURING	RICH CLIFTON	275 SO. RANCHO AVE.		COLTON, CA 92324
CITY OF LAKE ELSINORE	KEVIN SHEAR	BUILDING & SAFETY DIVISION	130 S. MAIN	LAKE ELSINORE, CA 92330
CITY OF LAKE ELSINORE	KEVIN SHEAR	BUILDING OFFICIAL	130 SOUTH MAIN STREET	LAKE ELSINORE, CA 92330

CITY OF FONTANA	DAVID J MARTINEZ	BUILDING OFFICIAL	P.O. BOX 518,	FONTANA, CA 92335-3598
CITY OF HEMET	BARNEY PHILLIPS	BUILDING OFFICIAL	450 EAST LATHAM AVENUE	HEMET, CA 92343
CITY OF HEMET	COLIN MC VIE	BUILDING DEPARTMENT	450 E. LATHAM AVENUE	HEMET, CA 92343
CITY OF HESPERIA	TOM HARP	BUILDING OFFICIAL	15776 MAIN STREET	HESPERIA, CA 92345
CITY OF HIGHLAND	BUILDING OFFICIAL	26935 BASELINE		HIGHLAND, CA 92346
HALLMARK SOUTH WEST CORP.	25525 REDLANDS BOULEVARD			LOMA LINDA, CA 92354
CITY OF LOMA LINDA	A.J. ALLDREDGE	BUILDING OFFICIAL	25541 BARTON ROAD	LOMA LINDA, CA 92354
HALLMARK SOUTH WEST CORP.	ATTN: JOHN WALKER	25525 REDLANDS BOULEVARD		LOMA LINDA, CA 92354
PRESIDENT	RUSS LORENZ	STABILIZER SYSTEMS, INC.	P.O. BOX 1506	LOMA LINDA, CA 92354
CITY OF NEEDLES	TIM DUNCAN	BUILDING OFFICIAL	817 THIRD ST.	NEEDLES, CA 92363
CALIF. VEHICLE REGISTRATION SERVICES	LEANNE	515-D NEW JERSEY STREET		REDLANDS, CA 92373
CITY OF REDLANDS	NICK J ANDERSON	BUILDING DEPARTMENT	P.O. BOX 3005	REDLANDS, CA 92373
CITY OF REDLANDS	NICK J ANDERSON	BUILDING OFFICIAL	P.O. BOX 3005	REDLANDS, CA 92373
CITY OF RIALTO	MYRA TOLES	BUILDING OFFICIAL	131 SOUTH WILLOW AVENUE	RIALTO, CA 92376
CHIEF BUILDING OFFICIAL	MYRA TOLES	CITY OF RIALTO, BUILDING DEPARTMENT	131 SO. WILLOW AVENUE	RIALTO, CA 92376
CITY OF SAN JACINTO	BRIAN MC NABB	BUILDING DEPARTMENT	P.O. BOX 488	SAN JACINTO, CA 92383
CITY OF SAN JACINTO	BRIAN MC NABB	BUILDING OFFICIAL	PO BOX 488, 201 EAST MAIN STREET	SAN JACINTO, CA 92383
APAPAS DEVELOPMENT CO.	ERNIE SALGADO	P O BOX 726		SAN JACINTO, CA 92383
CITY OF VICTORVILLE	GEORGE E WORLEY	BUILDING OFFICIAL	14343 CIVIC DRIVE	VICTORVILLE, CA 92392
ROBINSON ED	12582 SECOND STREET, SPACE 58			YUCAIPA, CA 92399
RENT ADMINISTRATOR	DAVE OWNES	CITY OF YUCAIPA	34282 YUCAIPA BLVD	YUCAIPA, CA 92399
CITY OF YUCAIPA	JOHN NC NAINS	BUILDING OFFICIAL	34289 YUCAIPA BLVD	YUCAIPA, CA 92399
HOUSING IMPROVEMENT MANAGER	MR. GEORGE OWENS	OFFICE OF COMMUNITY DEVELOPMENT	385 N. ARROWHEAD AVE.	SAN BERNARDINO, CA 92415
COUNTY OF SAN BERNADINO	ROBERT JOHNSTON	BUILDING OFFICIAL	385 N. ARROWHEAD, FIRST FLOOR	SAN BERNADINO, CA 92415
COUNTY OF SAN BERNADINO	MYRA WESTERFIELD	DESH	385 NORTH ARROWHEAD	SAN BERNADINO, CA 92415-0160
CITY OF SAN BERNARDINO	BARBARA JOHNSTON	BUILDING OFFICIAL	385 NORTH ARROWHEAD AVE	SAN BERNARDINO, CA 92415-0181
BUILIDNG INSPECTOR III	ROBERT H MASSEY	COUNTY OF SAN BERNARDINO	172 WEST 3RD. ST., 6TH FLOOR	SAN BERNARDINO, CA 92415-0315
MOBILE HOME RENT BOARD	GERALD (JERRY) BUTLER	DIRECTOR	300 NORTH D STREET	SAN BERNARDINO, CA 92418
CITY OF SAN BERNARDINO	GERALD J BUTLER	300 NORTH D STREET		SAN BERNARDINO, CA 92418
CITY OF SAN BERNARDINO	LARRY E REED	BUILDING OFFICIAL	300 NORTH D STREET	SAN BERNARDINO, CA 92418
CITY OF SAN BERNARDINO	TOM ODELL	300 NORTH D		SAN BERNARDINO, CA 92418
DEPT. OF FORESTRY & LIFE PROTECTION	FIR PREVENTION SECTION	P.O. BOX 944246		SACRAMENTO, CA 92466-2460
ENVIRONMENTAL HEALTH RIVERSIDE COUNTY	ATTN: KEITH JONES	P O BOX 1206		RIVERSIDE, CA 92502
COUNTY OF RIVERSIDE	THOMAS H INGRAM	BUILDING OFFICIAL	P.O. BOX 1440	RIVERSIDE, CA 92502-1440
HOOD PLUMBING	CHRIS HELLER	6203 CREST AVE.		RIVERSIDE, CA 92503
C-THRU ALUMINUM AWNING COMPANY	P. O BOX 3160			RIVERSIDE, CA 92510-3160
BUILDING OFFICIAL	DAN CHUDY	CITY OF RIVERSIDE BLDG. DEPT	3900 MAIN STREET	RIVERSIDE, CA 92522
CITY OF RIVERSIDE	DON CHUDY	BUILDING OFFICIAL	3900 MAIN STREET	RIVERSIDE, CA 92522
CITY OF NEWPORT BEACH	RAIMAR W SCHULLER	BUILDING OFFICIAL	CITY HALL, 3300 NEWPORT BOULEVARD	NEWPORT BEACH, CA 92569
CITY OF PERRIE	CHARLES RAY	BUILDING OFFICIAL	101 NORTH D STREET	PERRIS, CA 92570-2220
CITY OF BREA	RICHARD O MITCHELL	BUILDING OFFICIAL	ONE CIVIC CENTER CIRCLE	BREA, CA 92621
STEVE HULLIBARGET	3920 RIDGE STREET			FAIR OAKS, CA 92628
CITY OF COSTA MESA	TONY C'DE BACA	BUILDING OFFICIAL	77 FAIR DRIVE	COSTA MESA, CA 92628-1200
WESTERN AWNING ASSOCIATION	1015 E. CHAPMAN AVENUE, STE. B			FULLERTON, CA 92631
J.P.D. DESIGN ASSOCIATES (R.V. ONLY)	WILLIAM GILLESPIE	1451 EAST CHAPMAN AVENUE		FULLERTON, CA 92631
BAUM ELECTRIC COMPANY	ATTN: BRYAN VAUGHAN	114-B SOUTH LEMON		FULLERTON, CA 92632
CITY OF FULLERTON	CHUCK DALEO	BUILDING OFFICIAL	303 WEST COMMONWEALTH AVENUE	FULLERTON, CA 92632
CITY OF FULLERTON, CITY HALL	CHUCK DALEO	DEVELOPMENT SERVICES DEPT.	303 W. COMMONWEALTH AVENUE	FULLERTON, CA 92632-1775
R&B COMMUNITIES	BRAD BRIGHAM	P.O. BOX 4098		FULLERTON, CA 92634
DAVID GRAF	12262 LORNA ST.			GARDEN GROVE, CA 92641
CITY OF GARDEN GROVE	JAMES MARTIN	BUILDING OFFICIAL	11391 ACACIA PKY., P.O. BOX 3070	GARDEN GROVE, CA 92642
CITY OF GARDEN GROVE	SANDRA PETERSON	BUILDING DEPARTMENT	P.O. BOX 3070	GARDEN GROVE, CA 92642
FALL-STOP CORPORATION	ATTN: M. L. BROWN	P O BOX 1549		HUNTINGTON BEACH, CA 92647
FALL-STOP CORPORATION	ATTN: MARVIN L. BROWN	P O BOX 1549		HUNTINGTON BEACH, CA 92647
FALL STOP	P O BOX 1549			HUNTINGTON BEACH, CA 92647
CHIEF COMBINATION INSPECTOR	LLOYD DICK	CITY OF HUNTINGTON BEACH	2000 MAIN STREET	HUNTINGTON BEACH, CA 92648
CITY OF HUNTINGTON BEACH	MIKE ADAMS	BUILDING OFFICIAL	2000 MAIN STREET	HUNTINGTON BEACH, CA 92648
SHORT STOP MANAGEMENT	HENRY SCHULTE	16222 MONTEREY LANE, SPACE 260		HUNTINGTON BEACH, CA 92649
CITY OF LAGUNA BEACH	JOHN GUSTAFSON	BUILDING OFFICIAL	505 FOREST AVENUE	LAGUNA BEACH, CA 92651-2394
CITY OF LAGUNA NIGEL	ROBERT LENARD	BUILDING OFFICIAL	27781 LA PAZRO	LAGUNA NIGEL, CA 92656
RICHARDSON, NAGY, MARTAIN PLANNING CO.	ATTN. MARK KINER	4611 TELLER AVENUE		NEWPORT BEACH, CA 92660
JBZ ARCHITECTURE & PLANNING	ATTN: JERRY BECKS	5010 CAMPUS DRIVE, SUITE 100		NEWPORT BEACH, CA 92660
CAPITAL W A T & G	PAUL DEGENKOLB	2260 UNIVERSITY DR.		NEWPORT BEACH, CA 92660
WESTERN GROWERS ASSOCIATION	ATTN: ELAINE WAKELIN	P. O. BOX 2130		NEWPORT BEACH, CA 92663
TOTO KIKI USA INC	ATTN; HIRO TAKEUCHI	415 WEST TAFT AVENUE, UNIT A		ORANGE, CA 92665
ROGER KERSEY	58 PLAZA SQUARE			ORANGE, CA 92666
CRAIG WHEELER	58 PLAZA SQUARE, STUDIO E			ORANGE, CA 92666
CITY OF ORANGE	BUILDING OFFICIAL	PO BOX 449, 300 E. CHAPMAN AVE., RM 12		ORANGE, CA 92666
CITY OF ORANGE	MAGGIE EDMISTON	BUILDING DEPARTMENT	300 E. CHAPMAN	ORANGE, CA 92666
CITY OF VILLA PARK	SCOTT R FAZEKAS	BUILDING OFFICIAL	17855 SANTIAGO BOULEVARD	VILLA PARK, CA 92667
MANUFACTURED HOUSING EDUC. TRUST	VICKIE TALLEY	500 N STATE COLLEGE BLVD., STE 1020		ORANGE, CA 92668-1637
CITY OF PLACENTIA	JOYCE R ROSENTHAL	BUILDING DEPARTMENT	401 E. CHAPMAN	PLACENTIA, CA 92670
CITY OF PLACENTIA	ROBERT CHANG	BUILDING OFFICIAL	401 EAST CHAPMAN	PLACENTIA, CA 92670
STEPHEN BRADFORD AND ASSOC.	STEPHEN BRADFORD	P.O. BOX 148		PLACENTIA, CA 92670

CITY OF SAN CLEMENTE	TRANG HUYNH	BUILDING DEPARTMENT	910 CALLE NEGOCIO	SAN CLEMENTE, CA 92672
CITY OF SAN CLEMENTE	TRANG HUYNH	BUILDING OFFICIAL	910 CALLE NEGOCIO, SUITE 100	SAN CLEMENTE, CA 92672
CITY OF SAN JUAN CAPISTRANO	DANIEL MC FARLAND	BUILDING DEPARTMENT	32400 PASEO ADELANTO	SAN JUAN CAPISTRANO, CA 92675
CITY OF SAN JUAN CAPISTRANO	MARK GIBSON	BUILDING OFFICIAL	32400 PASEO ADELANTO	SAN JUAN CAPISTRANO, CA 92675
PACIFIC TELEPHONE	ATTN: WM. C. BIBLE	3371 CAPSTAN DRIVE		LAGUNA NIGUEL, CA 92677
CITY OF PARAMOUNT	HOWARD E LARNARD	BUILDING OFFICIAL	137 SOUTH PROSPECT AVENUE	TUSTIN, CA 92680
CITY OF WESTMINISTER	FRANK MANLAPEG	BUILDING OFFICIAL	8200 WESTMINISTER AVENUE	WESTMINISTER, CA 92683
CITY OF YORBA LINDA	AHMAD H TABBAA	BUILDING OFFICIAL	4845 CASA LOMA AVENUE	YORBA LINDA, CA 92686
CITY OF MISSION VIEJO	SCOTT R FAZEKAS	BUILDING OFFICIAL	25909 PALA SUITE 150	MISSION VIEJO, CA 92691-2778
MR CLARENCE MOORE	SUPERVISING BUILDING INSPECTOR	400 CIVIC CENTER DRIVE WEST		SANTA ANA, CA 92701
ENV MGMT. AGENCY ORANGE CO.	ATTN: VINCENT DI STEFANO	P.O BOX 4048		SANTA ANA, CA 92702
ENVIRONMENTAL MGMT. AGENCY	COUNTY OF ORANGE	P O. BOX 4048		SANTA ANA, CA 92702
CITY OF SANTA ANA	JAMES LINDGREN	BUILDING OFFICIAL	P.O. BOX 1988 M-19	SANTA ANA, CA 92702
COUNTY OF ORANGE	CHI TRAM	BUILDING OFFICIAL	P.O. BOX 4048	SANTA ANA, CA 92702-4048
PLUMBERS & PIPE FITTERS LOCAL #582	ATTN: A.M. MC COY, JR.	3904 W. FIRST ST.		SANTA ANA, CA 92703
ORANGE COUNTY ENVIRONMENTAL HEALTH DIV.	JACK MILLER	DIRECTOR	2009 E EDINGER AVENUE	SANTA ANA, CA 92705-4720
ORANGE COUNTY ENVIRONMENTAL HEALTH DIV.	SUSAN KNIGHT	2009 E EDINGER AVENUE		SANTA ANA, CA 92705-4720
GOLDEN WEST HOMES	1801 E EDINGER AVE #240			SANTA ANA, CA 92705-4749
CITY OF FOUNTAIN VALLEY	MIKE BROTEMARKLE	BUILDING DEPARTMENT	10200 SLATER AVENUE	FOUNTAIN VALLEY, CA 92708
CITY OF FOUNTAIN VALLEY	MIKE BROTEMARKLE	BUILDING OFFICIAL	10200 SLATER AVENUE	FOUNTAIN VALLEY, CA 92708
CITY OF IRVINE	HELEN BROWN	INSPECTION DIVISION	1 CIVIC CENTER DRIVE 2, P.O. BOX 19575	IRVINE, CA 92713
IRVINE BUILDING DEPARTMENT	ROBERT STORCHEIM	1700 JAMBOREE ROAD	P.O. BOX 19575	IRVINE, CA 92713
DAMIELIAN & ASSOC., ARCHITECTS	60 CORPORATE PARK			IRVINE, CA 92714
RILEY BOWER INC.	ATTN: FRANK BOWER	2699 WHITE ROAD, SUITE 255		IRVINE, CA 92714
BGA ARCHITECTS	ATTN: MARK BOWER	2699 WHITE RD., SUITE 255		IRVINE, CA 92714
RICH C COLEMAN	100 PACIFICA S. 300			IRVINE, CA 92718
COLEMAN CASKEY ARCH.	RICH COLEMAN	100 PACIFICA S. 300		IRVINE, CA 92718
RAPHAEL HOMES	1309 S. EUCLID STREET			ANAHEIM, CA 92802-2001
CITY OF ANAHEIM	ARLENE RUELAZ	BUILDING PERMIT REPRESENTATIVE	P.O. BOX 3222	ANAHEIM, CA 92803
ROYAL ROOM OF CALIFORNIA	4050 S. ATCHISON			ANAHEIM, CA 92805
CITY OF ANAHEIM	JULIE SEAY	BUILDING OFFICIAL	P.O. BOX 3222	ANAHEIM, CA 92805
ADMIRAL ALUMINUM, INC. (PEBC)	1400 N. DALY STREET			ANAHEIM., CA 92806
LASCO INDUSTRIES	ATTN: LARRY WORKMAN	3255 E. MIRALOMA		ANAHEIM, CA 92806
PLUMBERS & PIPE FITTERS LOCAL #484	ATTN: FRANK SMITH	1955 N. VENTURA AVE.		VENTURA, CA 93001
CITY OF SAN BUENAVENTURA	BOB PRODOEHL	BUILDING OFFICIAL	PO BOX 99, 501 POLI STREET	SAN BUENAVENTURA, CA 93001
CITY OF VENTURA BUILDING & SAFETY DEPT.	BOB PRODOEHL	CITY OF SAN BUENAVENTURA	P.O. BOX 99, 501 POLI STREET	VENTURA, CA 93002
RASMUSSEN & ASSOCIATES	DAVID SARGENT	248 SOUTH MILLS ROAD		VENTURA, CA 93003
COUNTY OF VENTURA	JACK PHILLIPS	BUILDING OFFICIAL	800 SOUTH VICTORIA AVENUE	VENTURA, CA 93009
SHEEHAN AND ASSOCIATES	305 CALLE HIGUERA			CAMARILLO, CA 93010
CITY OF CAMARILLO	DIC PETERSON .	DIVISION OF BUILDING & SAFETY	601 CARMEN DRIVE	CAMARILLO, CA 93010
CITY OF CAMARILLO	GREG ROBINSON	BUILDING OFFICIAL	601 CARMEN DRIVE	CAMARILLO, CA 93010
CITY OF CARPINTERIA	TED R DELIANEDIS	BUILDING OFFICIAL	5775 CARPINTERIA AVENUE	CARPINTERIA, CA 93013
CITY OF FILLMORE	VERN GILL	BUILDING OFFICIAL	250 CENTRAL AVE	FILLMORE, CA 93015
FRANK HARWOOD	1913 MEINERS ROAD			OJAI, CA 93023
CITY OF OJAI	JACK DE JONG	BUILDING OFFICIAL	P.O. BOX 1570	OJAI, CA 93023
PLASTICS BORG-WARNER CORPORATION	ATTN: A. J. LONG	P.O. BOX 449 301 E. WOOLEY ROAD		OXNARD, CA 93032
CITY OF OXNARD	GEORGE O POPE	BUILDING OFFICIAL	241 WEST SECOND STREET	OXNARD, CA 93035
CITY OF PORT HUENEME	JAMES L SMITH	BUILDING OFFICIAL	250 NORTH VENTURA ROAD	PORT HUENEME, CA 93041
DIRECTOR OF COMMUNITY DEVELOPMENT	TOM FIGG	CITY OF PORT HUENEME	250 NORTH VENTURA ROAD	PORT HUENEME, CA 93041
CITY OF SANTA PAULA	STEPHEN R STUART	BUILDING OFFICIAL	P.O. BOX569	SANTA PAULA, CA 93060
CITY OF SIMI VALLEY	GADDIS FARMER	BUILDING OFFICIAL	2929 TAPO CANYON ROAD	SIMI VALLEY, CA 93063
RON UHLES	924 ANACAPA STREET			SANTA BARBARA, CA 93101
REDWOOD CALIFORNIA LTD.	ADRIN CHAMBERLAIN	112 EAST DE LA GUERRA ST. STUDIO 4		SANTA BARBARA, CA 93101
PLUMBERS & PIPE FITTERS LOCAL #114	ATTN: AL ALLOCA	415 CHAPALA STREET		SANTA BARBARA, CA 93101
SANTA BARBARA COUNTY BUILDING DEPARTMENT	FRANK BECKENRIDGE	BUILDING OFFICIAL	123 E. ANAPAMU STREET	SANTA BARBARA, CA 93101
COUNTY OF SANTA BARBARA	FRANK BRECKENRIDGE	BUILDING OFFICIAL	123 EAST ANAPAMU STREET	SANTA BARBARA, CA 93101
PENFIELD & SMITH ENGINEERS	P.O. BOX 98			SANTA BARBARA, CA 93102
CITY OF SANTA BARBARA	ROY HAWTHORNE	BUILDING OFFICIAL	P.O. BOX 1990	SANTA BARBARA, CA 93102
CITY OF ARVIN	HOWARD PHILLIPS	BUILDING DEPARTMENT, PLANNING DIRECTOR	P.O. BOX 548	ARVIN, CA 93203
CITY OF ARVIN	TED VANANSTEL	BUILDING OFFICIAL	P.O. BOX 548	ARVIN, CA 93203
CITY OF AVENAL	JERRY WATSON	BUILDING OFFICIAL	919 SKYLINE BLVD.	AVENAL, CA 93204
CITY OF AZUSA	ROY BRUCKNER	BUILDING OFFICIAL	213 EAST FOOTHILL BOULEVARD	AZUSA, CA 93204
CITY OF COALINGA	STEVEN R ASLESEN	BUILDING OFFICIAL	CITY HALL, 150 WEST ELM AVENUE	COALINGA, CA 93210
CITY OF DELANO	GARY C LANGSTON	BUILDING OFFICIAL	1015 ELEVENTH AVENUE	DELANO, CA 93215
CITY OF EXETER	ROY CHACE	BUILDING OFFICIAL	137 NORTH F STREET	EXETER, CA 93221
CITY OF FARMERSVILLE	JIM WILLIAMS	BUILDING OFFICIAL	147 EAST FRONT STREET	FARMERSVILLE, CA 93223
CITY OF HANFORD	BUILDING OFFICIAL	317 NO. DOUTY STREET		HANFORD, CA 93230
CITY OF CORCORAN	CHARLES GARDNER	BUILDING OFFICIAL	1033 CHITTENDEN	CORCORAN, CA 93230
COUNTY OF KINGS	WILLIAM ZUMWALT	BUILDING OFFICIAL	1400 LACEY BOULEVARD	HANFORD, CA 93230
CITY OF HURON	BUILDING DEPARTMENT	16900 5TH STREET		HURON, CA 93234
CITY OF HURON	JOHN LUTHY	BUILDING OFFICIAL	P.O. BOX 339	HURON, CA 93234
CITY OF LEMOORE	RAY RODARMEL	BUILDING OFFICIAL	406 B STREET	LEMOORE, CA 93245
CITY OF LINDSAY	WENDAL BOSEBY	BUILDING OFFICIAL	P.O. BOX 369, 251 HONOLULU STREET	LINDSAY, CA 93247
CITY OF MC FARLAND	DALE L MILLS	BUILDING OFFICIAL	400 KERN STREET	MC FARLAND, CA 93250

CITY OF PORTERVILLE	ROBERT OATES	BUILDING OFFICIAL	P.O. BOX 432, 291 N. MAIN ST.	PORTERVILLE, CA 93257
CITY OF PORTERVILLE	ROBERT OATES	BUILDING DEPARTMENT	P.O. BOX 432	PORTERVILLE, CA 93258
CITY OF SHAFTER	JOHN J GUINN	BUILDING OFFICIAL	336 PACIFIC	SHAFTER, CA 93263
CITY OF TAFT	BILL NAPIER	BUILDING OFFICIAL	209 EAST KERN STREET	TAFT, CA 93268
CITY OF MARICOPA	ED WARD	BUILDING OFFICIAL	P.O. BOX 546, 315 LINCOLN	TAFT, CA 93268
MYRON SMITH	P.O. BOX A			TAFT, CA 93268
CITY OF TULARE	LYLE E HOOD	BUILDING OFFICIAL	CITY HALL, 411 EAST KERN AVENUE	TULARE, CA 93274
SELF-HELP ENTERPRISES	ATTN: WILLIAM FRENCH	P. O. BOX 351		VISALIA, CA 93277
COUNTY OF TULARE	DAVID DEAN	BUILDING OFFICIAL	5961 SOUTH MOONEY BLVD.	VISALIA, CA 93277
TULARE COUNTY RESOURCE MANAGEMENT AGENCY	CATHERINE ANDERSEN	5961 S MOONEY BLVD		VISALIA, CA 93277-9394
TULARE COUNTY RESOURCE MANAGEMENT AGENCY	MIKE COFFIELD	DIRECTOR	5961 S MOONEY BLVD	VISALIA, CA 93277-9394
CITY OF WASCO	BENNIE WILKINSON	BUILDING OFFICIAL	PO BOX 836, 746 8TH STREET	WASCO, CA 93280
CITY OF WOODLAKE	JACK JUSTICE	BUILDING OFFICIAL	350 N. VALENCIA BLVD.	WOODLAKE, CA 93286
CITY OF VISALIA	BEN OWENS	BUILDING OFFICIAL	707 WEST ACEQUIA STREET	VISALIA, CA 93291
CITY OF BAKERSFIELD	CALVIN BIDWELL	BUILDING DEPARTMENT	1501 TRUXTUN AVENUE	BAKERSFIELD, CA 93301
CITY OF BAKERSFIELD	DENNIS C FIDLER	BUILDING OFFICIAL	1715 CHESTER AVENUE	BAKERSFIELD, CA 93301
KERN COUNTY ENVIRONMENTAL HEALTH	GUY SHAW	2700 M STREET, SUITE 300		BAKERSFIELD, CA 93301
COUNTY OF KERN	LARRY GARRATT	BUILDING OFFICIAL	2700 M STREET, SUITE 100	BAKERSFIELD, CA 93301
KERN COUNTY ENVIRONMENTAL HEALTH	STEVE MC CALLEY	DIRECTOR	2700 M STREET, SUITE 300	BAKERSFIELD, CA 93301
PRESIDENT	JOANNE WILHITE	K.C.M.O.A.	8500 KERN CANYON RD., SP.136	BAKERSFIELD, CA 93306
GSMOL REGIONAL DIRECTOR	VI MONSON	6601 EUCALYPTUS #70		BAKERSFIELD, CA 93306
STEVE WEBB	5832 LEMBROKE AVE.			BAKERSFIELD, CA 93308
PLUMBERS & PIPE FITTERS LOCAL #460	ATTN: JEFF BRYSON	6718 MEANY AVE.		BAKERSFIELD, CA 93308
MARK AUGUSTINE	4000 MING AVE.			BAKERSFIELD, CA 93309
MOBILEHOME OWNERS ASSOC. OF KERN CO.	JOANNE WILHITE, PRESIDENT	P.O. BOX 60555		BAKERSFIELD, CA 93386-0555
KERN COUNTY MOBILEHOME OWNER'S ASSOC.	P.O. BOX 60555			BAKERSFIELD, CA 93386-0555
RESKA & ASSOCIATES	1261 MILL STREET			SAN LUIS OBISPO, CA 93401
PLUMBERS & PIPE FITTERS LOCAL #403	ATTN: SID STOLPER	3710 BROAD STREET	990 PALM STREET, BOX 8100	SAN LUIS OBISPO, CA 93401
CITY OF SAN LUIS OBISPO	THOMAS BAASCH	BUILDING OFFICIAL	COUNTY GOV. CENTER COURTHOUSE, ROOM 310	SAN LUIS OBISPO, CA 93403-8100
COUNTY OF SAN LUIS OBISPO	BARNEY MCCAY	BUILDING OFFICIAL	COURTHOUSE ANNEX, COURT ROOM 310	SAN LUIS OBISPO, CA 93408
COUNTY OF SAN LUIS OBISPO, CO. PLANNING	BARNEY MCCAY	BUILDING OFFICIAL	P.O. BOX 550	SAN LUIS OBISPO, CA 93408
CITY OF ARROYO GRANDE	LARRY SCHMIDT	BUILDING OFFICIAL	6500 PALMA AVENUE ROOM 104	ARROYO GRANDE, CA 93420
CITY OF ATASCADERO	DAVID G MATTHEWS	BUILDING OFFICIAL	P.O. BOX 365, 154 SO. 8TH ST.	ATASCADERO, CA 93422
CITY OF GROVER BEACH	CHRIS THYRRING	BUILDING OFFICIAL	P.O. BOX 788, 918 OBISPO STREET	GROVER CITY, CA 93433
CITY OF GUADALUPE	FRANK BRECKENRIDGE	BUILDING OFFICIAL		GUADALUPE, CA 93434
RUTH LOWY	HOUSING REFERRAL OFFICER	4392 CES DEHR	100 CIVIC CENTER PLAZA	VANDENBERG AFB, CA 93437
CITY OF LOMPOC	ED PENNA	BUILDING OFFICIAL	595 HARBOR STREET	LOMPOC, CA 93438
CITY OF MORRO BAY	JAMES R NICKLAS	BUILDING OFFICIAL	1000 SPRING STREET	MORRO BAY, CA 93442
CITY OF PASO ROBLES	DOUG MONN	BUILDING OFFICIAL		PASO ROBLES, CA 93446
CITY OF PISMO BEACH	BUILDING OFFICIAL	1000 BELLO STREET	110 EAST COOK STREET	PISMO BEACH, CA 93449
CITY OF SANTA MARIA	WILLIAM H ORDOFF	BUILDING OFFICIAL	21000 HACIENDA BOULEVARD	SANTA MARIA, CA 93454
CITY OF CALIFORNIA CITY	MIKE SHAHABAKHTI	BUILDING OFFICIAL		CALIFORNIA CITY, CA 93505
RICHARD HILL	RT 4, BOX 35			BENTON, CA 93512
UNION CARBIDE CORPORATION	ATTN: ROBERT F. HAYES	METALS DIVISION	207 WEST SOUTH STREET	BISHOP, CA 93514
COUNTY OF INYO	MICHAEL S CONKLIN	BUILDING OFFICIAL	207 WEST SOUTH STREET	BISHOP, CA 93514
INYO CO. BUILDING DEPARTMENT	MIKE CONKLIN	BUILDING OFFICIAL	377 W. LINE STREET	BISHOP, CA 93514
CITY OF BISHOP	OTTIE BEAR	BUILDING DEPARTMENT	P.O. BOX 1236	BISHOP, CA 93514
CITY OF BISHOP	OTTIE BEAR	BUILDING OFFICIAL		BISHOP, CA 93515
CITY OF LANCASTER	BUILDING OFFICIAL	44933 FERN AVENUE	44933 NORTH FERN AVENUE	LANCASTER, CA 93534
CITY OF LANCASTER	FRED NORTON	BUILDING OFFICIAL	PO BOX 347	LANCASTER, CA 93534
COUNTY OF MONO	BOB FLOYD	BUILDING OFFICIAL	P.O. BOX 1609	MAMMOTH LAKES, CA 93546
CITY OF MAMMOTH LAKES	CHARLES KAROLY	BUILDING OFFICIAL	710 EAST PALMDALE BOULEVARD	MAMMOTH LAKES, CA 93546
CITY OF PALMDALE	CRAIG T SCOTT	BUILDING OFFICIAL	100 W. CALIFORNIA AVE	PALMDALE, CA 93550
CITY OF RIDGECREST	HARVEY COLLISON	BUILDING OFFICIAL		RIDGECREST, CA 93555
DESERT WEST CONSTRUCTION	ROBERT OR VALERIE MARTINEZ	775 65TH ST. WEST		ROSAMOND, CA 93560
DESERT WEST CORPORATION	ROBERT OR VALERIE MARTINEZ	775 65TH STREET WEST		ROSAMOND, CA 93560
NATL. ELECTRICAL MANUFACTURES ASSN.	ATTN: RADNOR W. WORTHING	33940 TOCALOMA RAOD		AUBERRY, CA 93602
NATL. ELECTRICAL MFGRS. ASSN.	ATTN: RADNOR W. WORTHING	33940 TOCALOMA ROAD		AUBERRY, CA 93602
CITY OF CHOWCHILLA	DAN NICHOLS	BUILDING OFFICIAL	145 ROBERTSON BOULEVARD	CHOWCHILLA, CA 93610
ALLEN CORNELISON	5872 N. BEHTEL			CLOVIS, CA 93611
VEREETA LUCIETTA REAL ESTATE	543 SCOTT			CLOVIS, CA 93612
CITY OF CLOVIS BLDG. INSPECT.	DIV. SUPERVISOR	1033 5TH STREET		CLOVIS, CA 93612
CITY OF CLOVIS	STEVE BAKER	BUILDING OFFICIAL	1033 FIFTH STREET	CLOVIS, CA 93612
CITY OF DINUBA	MILTON A TROMBORG	BUILDING OFFICIAL	405 EAST EL MONTE WAY	DINUBA, CA 93618
CITY OF DINUBA	PAUL E MAGYER	BUILDING DEPARTMENT	405 E. EL MONTE WAY	DINUBA, CA 93618
CITY OF DOS PALOS	FRANK BASULTO	BUILDING OFFICIAL	1546 GOLDEN GATE AVENUE	DOS PALOS, CA 93620
CITY OF FIREBAUGH	BUD NEWBY	BUILDING OFFICIAL	1575 11TH STREET	FIREBAUGH, CA 93622
CITY OF FOWLER	JAMES GRIGSBY	BUILDING OFFICIAL	128 S 5TH ST.	FOWLER, CA 93625-2401
MARTA MEZA	15760 W. CALIFORNIA			KERMAN, CA 93630
CITY OF KERMAN	DAVID RANDALL	BUILDING OFFICIAL	850 SO. MADERA AVE.	KERMAN, CA 93630
CITY OF KINGSBURG	DONALD E CLARK, CBO	BUILDING OFFICIAL	P.O. BOX 397, 1401 DRAPER STREET	KINGSBURG, CA 93631-0897
CITY OF LOS BANOS	JERRY PARSON	BUILDING OFFICIAL	P.O. BOX 31, 520 J STREET	LOS BANOS, CA 93635
MERCED COUNTY ENVIRONMENTAL HEALTH	JOHN ISOM	415 F STREET		LOS BANOS, CA 93635
BOB PEREZ	135 WEST YOSEMITE AVENUE			MADERA, CA 93637

CITY OF MADERA	LARRY MC CLINTOCK	BUILDING OFFICIAL	205 WEST FOURTH STREET	MADERA, CA 93637
CITY OF MENDOTA	JOE ESCODEDO	BUILDING OFFICIAL	643 QUINCE STREET	MENDOTA, CA 93640
CITY OF ORANGE COVE	BAY MAURICIO	BUILDING OFFICIAL	633 SIXTH STREET	ORANGE COVE, CA 93646
CITY OF PARLIER	ENCARNACION PATLAN	BUILDING OFFICIAL	1100 EAST PARLIER AVENUE	PARLIER, CA 93648
CITY OF REEDLEY	GLENN R QUINN	BUILDING OFFICIAL	845 G STREET	REEDLEY, CA 93654
CITY OF SANGER	STEPHEN A SCHWARTZ	BUILDING OFFICIAL	1700 SEVENTH STREET	SANGER, CA 93657
CITY OF SAN JOAQUIN	BOB WILBURN	BUILDING OFFICIAL	PO BOX 758, 21900 COLORADO STREET	SAN JOAQUIN, CA 93660
CITY OF SELMA	JOE FILANOWSKI	BUILDING OFFICIAL	1814 TUCKER STREET	SELMA, CA 93662
CENTRAL PIERS	DOUG LADD	PRESIDENT	284 N. THORNE	FRESNO, CA 93706
TOWN & COUNTRY	NOREINE GHILOTTI	1500 SHAW		FRESNO, CA 93711
FRESNO CO. COMMUNITY DEV. DEPT	ATTN: SR. BUILDING INSPECTOR	2220 TULARE STREET, 6TH FLOOR		FRESNO, CA 93721
COUNTY OF FRESNO	JIM WITTE	BUILDING OFFICIAL	2220 TULARE STREET, 6TH FLOOR	FRESNO, CA 93721
CITY OF FRESNO	RAY G COLLIER	BUILDING OFFICIAL	2220 TULARE, 6TH FLOOR STE. A	FRESNO, CA 93721-1899
DEPT HEALTH SERVICES	UNIV. AT FRESNO CALIFORNIA ST.	ATTN: DR SANFORD BROWN, CHRMN	SHAW & CEDAR AVES.	FRESNO, CA 93740
FRESNO COUNTY ENVIRONMENTAL HEALTH SYS.	C.O. SEAMAN	P.O BOX 11867		FRESNO, CA 93775
FRESNO COUNTY ENVIRONMENTAL HEALTH SYS.	GARY CAROZZA	DIRECTOR	P.O. BOX 11867	FRESNO, CA 93775
THE SWANSON COMPANY	1930 W. WHITEBRIDGE AVE.	P.O. BOX 12423		FRESNO, CA 93777-2423
MOISES VASQUEZ	658 TERRACE STREET			SALINAS, CA 93901
PLUMBERS & PIPE FITTERS LOCAL # 503	ATTN: ROBERT HOWARD	117 PAJARO		SALINAS, CA 93901
CITY OF SALINAS	DAVID PASQUINELLI	BUILDING OFFICIAL	65 WEST ALISAL STREET	MONTEREY, CA 93901
COUNTY OF MONTEREY	BEN PHILLIPS	BUILDING OFFICIAL	240 CHURCH STREET	SALINAS, CA 93902
MONTEREY CO. BLD/O ASSN OF CA	C/O DIR. OF BLDG. INSPECTION	P.O. BOX 1208		SALINAS, CA 93902
MONTEREY COUNTY PLANNING DEPT.	FRANK BRUNINGS	P O BOX 1208	P.O. BOX 1208	SALINAS, CA 93902
MONTEREY COUNTY BUILDING DEPT.	JIM WALKER	BUILDING OFFICIAL		SALINAS, CA 93902
MONTEREY COUNTY HEALTH DEPARTMENT	ROBERT A SMITH	1270 NATIVIDAD ROAD		SALINAS, CA 93906
MONTEREY COUNTY ENVIRONMENTAL HEALTH	SUSAN RIMANDO	1270 NATIVIDAD ROAD	1270 NATIVIDAD ROAD	SALINAS, CA 93906
MONTEREY COUNTY ENVIRONMENTAL HEALTH	WALTER F WONG	DIRECTOR	P.O. BOX DRAWER G, CITY HALL	SALINAS, CA 93906
CITY OF CARMEL-BY-THE-SEA	TIM MERONEY	BUILDING OFFICIAL	P.O. BOX 647	CARMEL-BY-THE-SEA, CA 93921
CITY OF GONZALES	JOSEPH ONCAY	BUILDING DEPARTMENT	P.O. BOX 647, 109 FOURTH STREET	GONZALES, CA 93926
CITY OF GONZALES	RONALD W KINGSFORD	BUILDING OFFICIAL	213 EL CAMINO REAL, P.O. BOX 127	GONZALES, CA 93926
CITY OF GREENFIELD	JOHN ALVES	BUILDING OFFICIAL	P.O. BOX 127	GREENFIELD, CA 93927
CITY OF GREENFIELD	ROBERT MORRIS	BUILDING OFFICIAL/CITY PLANNER	212 SOUTH VANDERHURST AVENUE	GREENFIELD, CA 93927
CITY OF KING	DAVE VAN ETTEN	BUILDING OFFICIAL		KING CITY, CA 93930
MONTEREY COUNTY	JIM DEVINE	102 BROADWAY	211 HILCREST AVENUE	KING CITY, CA 93930
CITY OF MARINA	JIM MATTHEWS	BUILDING DEPARTMENT	211 HILLCREST AVENUE	MARINA, CA 93933
CITY OF MARINA	JIM MATTHEWS	BUILDING OFFICIAL		MARINA, CA 93933
PLUMBERS & PIPE FITTERS LOCAL #62	ATTN: JOHN BANDARRA	778 HAWTHORNE STREET	650 CANYON DEL REY ROAD	MONTEREY, CA 93940
CITY OF DEL REY OAKS	JAMES E ADAMS	BUILDING OFFICIAL	COLTON HALL	DEL REY OAKS, CA 93940
CITY OF MONTEREY	STEVEN R HARPER	BUILDING OFFICIAL	300 16TH STREET	MONTEREY, CA 93940
CITY OF PACIFIC GROVE	DALE FOLEY	BUILDING OFFICIAL		PACIFIC GROVE, CA 93950
MARY ANN WEEMS, CITY MANAGER	CITY OF SAND CITY	1 SYLVAN WAY	1 SYLVAN PARK	SAND CITY, CA 93955
CITY OF SAND CITY	JOHN VILLALPANDO	BUILDING OFFICIAL		SAND CITY, CA 93955
COMMUNITY DEVELOPMENT DIRECTOR	MR. HAROLD CAMACHO	1600 LA SALLE AVE.		SEASIDE, CA 93955
CITY OF SEASIDE	SALVADOR DISALVO	BUILDING OFFICIAL	P.O. BOX 810	SEASIDE, CA 93955-0810
CITY OF SOLEDAD	OTIS JUSTICE	BUILDING OFFICIAL	P.O. BOX 156	SOLEDAD, CA 93960
CITY OF BELMONT	RICHARD JOW	BUILDING OFFICIAL	1365 FIFTH AVENUE	BELMONT, CA 94002
CITY OF BRISBANE, PLANNING DIRECTOR	CAROL NELSON	BUILDING DEPARTMENT	150 NORTH HILL DRIVE, SUITE 40	BRISBANE, CA 94005
CITY OF BRISBANE	ROBIN LEITER	BUILDING OFFICIAL	150 NORTH HILL DRIVE	BRISBANE, CA 94005
PLUMBERS & PIPE FITTERS LOCAL #467	ATTN: THOMAS HUNTER	1519 ROLLINS ROAD		BURLINGAME,, CA 94010
PLMBRS/STEAMFITTERS LOCAL #467	ATTN: THOMAS HUNTER, BUS/MGR.	1519 ROLLINS ROAD		BURLINGAME, CA 94010
PLUMBERS & STEAMFITTERS LOCAL # 467	ATTN: THOMAS HUNTER, BUSINESS MANAGER	1519 ROLLINS ROAD		BURLINGAME, CA 94010
PLUMBERS & STEAMFITTERS LOCAL #467	ATTN: THOMAS HUNTER, BUSINESS MANAGER	1519 ROLLINS ROAD		BURLINGAME, CA 94010
PACIFIC COAST GAS ASSN.	ATTN: W. H. LOVING	1350 BAYSHORE HIGHWAY		BURLINGAME, CA 94010
CITY OF BURLINGAME	FRED CULLUM	BUILDING OFFICIAL	501 PRIMROSE ROAD	BURLINGAME, CA 94010
CITY OF HILLSBOROUGH	GUS ERBES	BUILDING OFFICIAL	1600 FLORIBUNDA AVENUE	HILLSBOROUGH, CA 94010
COTTONG TANIGUCHI LANDSCAPE ARCH.	RAY TEN	1105 BURLINGAME AVENUE		BURLINGAME, CA 94010
CITY OF COLMA	PAUL S SCHMIDT	BUILDING OFFICIAL	235 EL CAMINO REAL	COLMA, CA 94014
CITY OF DALY CITY	TERRY SEDIK	ECD DIRECTOR	333 90TH STREET	DALY CITY, CA 94015
CITY OF HALF MOON BAY	GARY E WHELEN	BUILDING OFFICIAL	501 MAIN STREET	HALF MOON BAY, CA 94019
HALF MOON BAY FIRE PROTECTION DISTRICT	210 SAN MATEO ROAD., #101			HALF MOON BAY, CA 94019-1708
LEAGUE OF WOMEN VOTERS	MS. ANN COOMBS	521 GUADALUPE DRIVE	1 NORTH SAN ANTONIO ROAD	LOS ALTOS, CA 94022
CITY OF LOS ALTOS	VANCE PHILLIPS	BUILDING OFFICIAL	26379 FREMONT RD.	LOS ALTOS, CA 94022
CITY OF LOS ALTOS HILLS	WILLIAM CARINO	BUILDING OFFICIAL	765 PORTOLA ROAD	LOS ALTOS HILLS, CA 94022
CITY OF PORTOLA VALLEY	PAUL SCHMIDT	BUILDING OFFICIAL		PORTOLA VALLEY, CA 94025
SRI INTERNATIONAL	SIDNEY EVERETT	333 RAVENSWOOD AVENUE	CIVIC CENTER, 701 LAUREL	MENLO PARK, CA 94025
CITY OF MENLO PARK	DONALD E JOHNSON	BUILDING OFFICIAL		MENLO PARK, CA 94025-3483
THE BOISE CONSTRUCTION CO.	C/O G.E.D.C.	BOX 2108	91 ASHFIELD ROAD	MENLO PARK, CA 94026-2108
CITY OF ATHERTON	MICHAEL A HOOD	BUILDING OFFICIAL	621 MAGNOLIA AVENUE	ATHERTON, CA 94027
CITY OF MILLBRAE	CHUCK GILLINGHAM	BUILDING OFFICIAL		MILLBRAE, CA 94030
NASA AMES RESEARCH CENTER	EMILIO TORRES	MAIL STOP 213-18	PO BOX 7540, 444 CASTRO STREET	MOFFET FIELD, CA 94035
CITY OF MOUNTAIN VIEW	RON GEARY	BUILDING OFFICIAL		MOUNTAIN VIEW, CA 94041
CITY OF MTN. VIEW	REHABILITATION SPECIALIST HOUSING SEC.	P.O. BOX 10		MOUNTAIN VIEW, CA 94042
PACIFICA PLANNING DEPT. CITY PLANNING	ADMINISTRATOR CITY HALL	170 SANTA MARIA AVE.		PACIFICA, CA 94044
CITY PLANNING ADMINISTRATOR	PACIFICA P. DEPT. CITY HALL	170 SANTA MARIA AVE.		PACIFICA, CA 94044

CITY OF PACIFICA	STEVEN BRANDVOLD	BUILDING OFFICIAL	170 SANTA MARIA AVENUE	PACIFICA, CA 94044
TOWN OF WOODSIDE	G. MICHAEL RICHARDS	BUILDING OFFICIAL	2955 WOODSIDE RD.	WOODSIDE, CA 94062
DESIGN/ENGINEERING SYST., INC.	ATTN: LINDA M. BUCHACA, C.E.	303 BRADFORD STREET		REDWOOD CITY, CA 94063
SAN MATEO COUNTY HEALTH SERVICES AGENCY	BRIAN J ZAMORA	DIRECTOR	455 COUNTY CENTER	REDWOOD CITY, CA 94063
HEALTH SERVICES AGENCY	BRIAN J ZAMORA	DIRECTOR	590 HAMILTON STREET	REDWOOD CITY, CA 94063
SAN MATEO COUNTY HEALTH SERVICES AGENCY	JIM YUEN	455 COUNTY CENTER		REDWOOD CITY, CA 94063
CITY OF SAN MATEO	STEVE DAVIS	BUILDING OFFICIAL	530 HAMILTON STREET	REDWOOD CITY, CA 94063
BLDG. INDUSTRY ASSOCIATION	WEST BAY DIVISION	595 PRICE AVENUE, SUITE 6		REDWOOD CITY, CA 94063
CITY OF BROADMOOR	WILLIAM CAMERON	BUILDING OFFICIAL	455 COUNTY CENTER, SECOND FLOOR	REDWOOD CITY, CA 94063
SAN MATEO COUNTY BUILDING INSPECTION	WILLIAM CAMERON	DEPARTMENT OF HEALTH SERVICES	590 HAMILTON STREET	REDWOOD CITY, CA 94063
COUNTY OF SAN MATEO	WILLIAM J CAMERSON	BUILDING OFFICIAL	455 COUNTY CENTER, 2ND FLOOR	REDWOOD CITY, CA 94063
CITY OF REDWOOD CITY	JOHN T LATORRA	BUILDING OFFICIAL	PO BOX 391, 1017 MIDDLEFIELD ROAD	REDWOOD CITY, CA 94063-0391
ALLEN LOSSIUS	2165 CRESTMOOR DRIVE			SAN BRUNO, CA 94066
CITY OF SAN BRUNO	RALPH CARRILLO	BUILDING OFFICIAL	567 EL CAMINO REAL	SAN BRUNO, CA 94066
A.S.I.S.	WALTER GLOSKOWSKI	130 EL CAMINO REAL		SAN CARLOS, CA 94070
CITY OF SAN CARLOS	JACK J AIELLO	BUILDING OFFICIAL	600 ELM STREET	SAN CARLOS, CA 94070-3085
CITY OF SOUTH SAN FRANCISCO	JEFFERY G BACA	BUILDING OFFICIAL	P.O. BOX711	SOUTH SAN FRANCISCO, CA 94083
CITY OF SUNNYVALE	HAMID POUYA	BUILDING OFFICIAL	456 WEST OLIVE AVENUE	SUNNYVALE, CA 94088
ROBERT LEINDECHEN	1225 VIENNA DRIVE, SPACE 268			SUNNYVALE, CA 94089
MOBILE HOME BOARD	BETTY TRIPP	BUILDING OFFICIAL		SUNNYVALE, CA 94089
DIV. OF OCCUPATIONAL SAFETY & HEALTH	ATTN: FRANK CIOFALO	1240 - C MOUNTAIN VIEW AL VISO ROAD		SAN FRANCISCO, CA 94101
DEPT. OF INDUSTRIAL RELATIONS	WILLIAM BECKER, CHIEF DEP. DIR	525 GOLDEN GATE AVE.		SAN FRANCISCO, CA 94101
PROPERTY CONSERVATION	MR. BERNARD CUMMINGS, ASST. SUPT	P. O. BOX 603	CITY HALL ANNEX, ROOM 101	SAN FRANCISCO, CA 94102
DIV. OF OCCUPATIONAL SAFETY & HEALTH	525 GOLDEN GATE AVE.	450 MC ALLISTER STREET		SAN FRANCISCO, CA 94102
SAN FRANCISCO WATER DEPARTMENT	ATTN: J. MATTHEW NULLAN			SAN FRANCISCO, CA 94102
CAL/OSHA	ATTN: VERNILA DAVIDSON	425 MASON STREET, 4TH FLOOR		SAN FRANCISCO, CA 94102
SUPERINTENDENTCO. PUBLIC WORKS	L.L. LITCHFIELD, P.E.	455 GOLDEN GATE	450 MC ALLISTER, ROOM 202	SAN FRANCISCO, CA 94102
THE STATE BAR OF CALIFORNIA	REAL PROPERTY LAW STAFF ATTY.	SAN FRANCISCO CO. PUBLIC WORKS		SAN FRANCISCO, CA 94102
CAROL TRUITT	1235 MISSION STREET	555 FRANKLIN STREET		SAN FRANCISCO, CA 94103
INDEPENDENT LIVING RESOURSE CENTER S. F.	70 - 10TH STREET			SAN FRANCISCO, CA 94103
AFL-CIO	ALBIN GRUHN	995 MARKET STREET, #310		SAN FRANCISCO, CA 94103
PLUMBERS & PIPE FITTERS LOCAL #38	ATTN: JOSEPH MAZZOLA	1621 MARKET STREET	1660 MISSION STREET, SIXTH FLOOR	SAN FRANCISCO., CA 94103
CITY OF SAN FRANCISCO	FRANK CHIU	BUILDING OFFICIAL	1660 MISSION STREET, SIXTH FLOOR	SAN FRANCISCO, CA 94103
COUNTY OF SAN FRANCISCO	FRANK CHIU	BUILDING OFFICIAL		SAN FRANCISCO, CA 94103
HERMAN, STOLLER & COLIVER	LISA KRAMER	66 GRACE ST.		SAN FRANCISCO, CA 94103
S.F. CHAMBER OF COMMERCE	ATTN: EDWARD LAWSON	465 CALIFORNIA STREET		SAN FRANCISCO, CA 94104
BLDG. OWNERS & MGRS. OF SAN FRANCISCO	ATTN: ELMER G. JOHNSON	465 CALIFORNIA ST., SUITE 504		SAN FRANCISCO, CA 94104
EQE INTERNATIONAL	44 MONTGOMERY STREET #3200			SAN FRANCISCO, CA 94104-4805
SO. PACIFIC TRANSPORTATION CO.	ATTN: GARY A. LASKO, ATTORNEY	ONE MARKET PLAZA		SAN FRANCISCO, CA 94105
DEL CAMPO MARU	ATTN: MARTIN DEL CAMPO	45 LANSING ST.		SAN FRANCISCO, CA 94105-2694
PACIFIC GAS & ELECTRIC CO	ATTN: C. JOHN BECK	123 MISSION STREET, ROOM 1226		SAN FRANCISCO, CA 94106
PACIFIC GAS & ELECTRIC COMPANY	GENERAL CONSTRUCTION DEPTS.	77 BEALE STREET, ROOM 1445		SAN FRANCISCO, CA 94106
PETER BELTON	303 SECOND STREET, ROOM 9072 S			SAN FRANCISCO, CA 94107
HARIDSON KOMATSU IVELICH & TUCKER	ATTN: MARK SEIBERLICH	400 SECOND STREET, SUITE 200		SAN FRANCISCO, CA 94107
HARDISON, KOMATSU, IVELICH &	TUCKER	400 SECOND STREET #200		SAN FRANCISCO, CA 94107-1402
SANDY & BABCOCK, ARCHITECTS	1349 LARKIN STREET			SAN FRANCISCO, CA 94109
BACKEN, ARRIGONI & ROSS	ATTN: STEVE SUNDMAN	1660 BUSH STREET		SAN FRANCISCO, CA 94109
TOM KARNES	4529 18TH STREET			SAN FRANCISCO, CA 94114
JOHN A. RAEBER AIA	519 TERESITA BLVD.			SAN FRANCISCO, CA 94127
ARCHITECTURE AND PLANNING	DEBBIE A GREEN	333 BROADWAY		SAN FRANCISCO, CA 94133
FARM LABOR CONTRACTOR EXAM.	LYNN STALEY	P.O. BOX 420603		SAN FRANCISCO, CA 94142
GOVERNMENT PUBLICATION SECTION	CALIF. STATE LIBRARY, LIBRARY/COURTS BLD	P.O. BOX 942837		SACRAMENTO, CA 94237 0001
OFFICE OF THE STATE FIRE MARSHAL	P.O. BOX 944246			SACRAMENTO, CA 94244-2400
WILBUR PROPERTIES	ANNE WILBUR	122 HAMILTON AVE.	250 HAMILTON AVE.	PALO ALTO, CA 94301
CA FIRE CHIEF'S ASSN.	JIM MCLAUGHLIN	PALO ALTO FIRE DEPT.		PALO ALTO, CA 94301
WILBUR PROPERTIES	ANNE WILBUR	122 HAMILTON AVENUE	250 HAMILTON AVENUE, PO BOX 10250	PALO ALTO, CA 94301-1616
CITY OF PALO ALTO	FRED M HERMAN	BUILDING OFFICIAL		PALO ALTO, CA 94303
RENT STABILIZATION PROGRAM DIRECTOR	GLORIA WILLIAMS	2415 UNIVERSITY AVENUE	2415 UNIVERSITY AVENUE	EAST PALO ALTO, CA 94303
CITY OF EAST PALO ALTO	JOHN COYLE	BUILDING OFFICIAL		EAST PALO ALTO, CA 94303
ANDY RAYMUNDO	SINCLAIR ASSOCIATE, INC.	15 N. ELLSWORTH, SUITE 100	610 FOSTER CITY BOULEVARD	SAN MATEO, CA 94401
CITY OF FOSTER CITY	RICHARD W NICHOLES	BUILDING OFFICIAL		FOSTER CITY, CA 94404
CITY OF ALAMEDA	GORDON PHILLIPS	2263 SANTA CLARA AVE., RM. 314	2263 SANTA CLARA AVENUE, ROOM 190	ALAMEDA, CA 94501
CITY OF ALAMEDA	STEVEN W DAVIS	BUILDING OFFICIAL		ALAMEDA, CA 94501
CITY OF ANTIOCH	RAYMOND VIGNOLA, CITY PLANNER	P.O. BOX 130	250 EAST L STREET	ANTIOCH, CA 94509
CITY OF BENICIA	BOB PARKER	BUILDING DEPARTMENT	250 EAST L STREET	BENICIA, CA 94510
CITY OF BENICIA	C. HARVEY HIGGS	BUILDING OFFICIAL	708 THIRD STREET	BENICIA, CA 94510
CITY OF BRENTWOOD	LOUIS R KIDWELL	BUILDING OFFICIAL	1232 WASHINGTON STREET	BRENTWOOD, CA 94513
CITY OF CALISTOGA	JAMES C MCCANN	BUILDING OFFICIAL	651 PINE ST., 3RD FLR. NO. WING	CALISTOGA, CA 94515
CITY OF CLAYTON	ROBERT GIESE	BUILDING OFFICIAL	1950 PARKSIDE DRIVE	MARTINEZ, CA 94517
CITY OF CONCORD	HAMID POUYA	BUILDING OFFICIAL		CONCORD, CA 94519
PHOENIX PROGRAMS, INC.	VICKI V SMITH	P.O. BOX 315		CONCORD, CA 94522
CONTRA COSTA COUNTY LIBRARY	1750 OAK PARK BLVD.			PLEASANT HILL, CA 94523
CITY OF DANVILLE	KEVIN GAYLY	BUILDING OFFICIAL	510 LA GONDA WAY	DANVILLE, CA 94526
FRANK BELLVINS	P.O. BOX 36			EL CERRITOS, CA 94530

CITY OF EL CERRITO	STEVE MITCHELL	BUILDING OFFICIAL	10890 SAN PABLO AVENUE	EL CERRITO, CA 94530
CITY OF ANTIOCH	GARY R RAYNER	BUILDING OFFICIAL	P.O. BOX 5007	ANTIOCH, CA 94531-5007
CITY OF FAIRFIELD	ALBERT E HURD	BUILDING OFFICIAL	1000 WEBSTER STREET	FAIRFIELD, CA 94533
COUNTY OF SOLANO	CHUCK PRATT	BUILDING OFFICIAL	601 TEXAS STREET	FAIRFIELD, CA 94533
CITY OF FREMONT	ROBERT EPPSTEIN	BUILDING OFFICIAL	P.O BOX 5006	FREMONT, CA 94537
INTERNATIONAL WINDOW	JENNY LABDELL	30526 SAN ANTONIO STREET		HAYWARD, CA 94544
COUNTY OF ALAMEDA	MARGARET ELLIOTT	BUILDING OFFICIAL	390 ELMHURST STREET, ROOM 141	HAYWARD, CA 94544
ALAMEDA COUNTY BUILDING DEPT.	MICHAEL HOOD	DEPARTMENT HEAD	399 ELMHURST ST., ROOM 141	HAYWARD, CA 94544
CITY OF HERCULES	GREGORY MC PHANN	BUILDING OFFICIAL	111 CIVIC DRIVE	HERCULES, CA 94547
CITY OF HERCULES	MARGARET ELLIOTT	BUILDING OFFICIAL	111 CIVIC DRIVE	CONTRA COSTA, CA 94547
CITY OF LIVERMORE	ROY ANDERSON	ACTING BUILDING OFFICIAL	1052 SOUTH LIVERMORE AVE.	LIVERMORE, CA 94550
CITY OF LIVERMOORE	STANLEY WHEELER	1052 SOUTH LIVERMORE AVENUE		LIVERMORE, CA 94550
SANDRA NIELSEN	18703 W. CAVENDISH DRIVE			CASTRO VALLEY, CA 94552
NATL. ELEC CONTRACTORS ASSN. INC.	ATTN: MICHAEL GELLER	1024 COURT STREET		MARTINEZ, CA 94553
NATL ELECTRICAL CONTRACTORS ASSN., INC.	ATTN: MICHAEL GELLER	1024 COURT STREET		MARTINEZ, CA 94553
PLUMBERS & PIPE FITTERS LOCAL #159	ATTN: WM. COSS	1308 ROMAN WAY		MARTINEZ, CA 94553
COUNTY OF CONTRA COSTA	CARLOS BALTODANO	BUILDING OFFICIAL	651 PINE ST. 3RD FLOOR	MARTINEZ, CA 94553
CITY OF MORAGA	ROBERT GIESE	BUILDING OFFICIAL	651 PINE ST.,3RD FLR NO WING	MARTINEZ, CA 94553
CITY OF LAFAYETTE	ROBERT GIESE	BUILDING OFFICIAL	651 PINE ST.- 3RD. FL. N.WING	MARTINEZ, CA 94553
SPECIAL PROGRAM CO-ORDINATOR	WILLIAM MARTINDALE	CONTRA COSTA CO., BLDG. DEPT.	651 PINE STREET	MARTINEZ, CA 94553
CITY OF MARTINEZ	DAVID SCOLA	BUILDING OFFICIAL	525 HENRIETTA STREET	MARTINEZ, CA 94553-2394
N	33275 GREAT SALT LAKE DR.			FREEMONT, CA 94555
PAUL DE FALCO	117 NATALIE DRIVE	1111 JEFFERSON STREET		MORAGA, CA 94556
THE CODE CONSORTIUM	FIRE PROTECTION ENGINEERS	BUILDING OFFICIAL	1800 FIRST STREET, PO BOX 660	NAPA, CA 94557
CITY OF NAPA	GRAHAM A LANG	BUILDING OFFICIAL	1195 3RD STREET ROOM 210	NAPA, CA 94558
CITY OF YOUNTVILLE	GARY BREWEN	BUILDING OFFICIAL	1195 THIRD STREET ROOM 210	NAPA, CA 94559
COUNTY OF NAPA	GARY W BREWEN	1195 THIRD STREET, ROOM 101		NAPA, CA 94559
NAPA COUNTY ENVIRONMENTAL HEALTH	RUBEN OROPEZA	DIRECTOR	1195 THIRD STREET, ROOM 101	NAPA, CA 94559
NAPA COUNTY ENVIRONMENTAL HEALTH	TRENT CAVE	DEPT. OF ENVIRONMENTAL HEALTH	1195 THIRD STREET, ROOM #205	NAPA, CA 94559
NAPA COUNTY	TRENT CAVE, DIRECTOR	BUILDING OFFICIAL	37101 NEWARK BOULEVARD	NAPA, CA 94559
CITY OF NEWARK	CHARLES DODGE			NEWARK, CA 94560
CHARLES WILCOXSON	105 CORAL DRIVE	BUILDING OFFICIAL	26 ORINDA WAY	ORINDA, CA 94563
CITY OF ORINDA	IRWIN KAPLIN	634 MARLESTA		ORINDA, CA 94563
PLUMBERS LOCAL #159	GLENN STRIDING	BUILDING OFFICIAL	2121 PEAR STREET	PINOLE, CA 94564
CITY OF PINOLE	MARC GRISHAM	BUILDING DEPARTMENT	P.O. BOX 1518	PINOLE, CA 94564
CITY OF PITTSBURG	JOHN LITTLE	BUILDING OFFICIAL	PO BOX 1518, CITY HALL	PITTSBURG, CA 94565
CITY OF PITTSBURG	JOHN LITTLE	BUILDING OFFICIAL	PO BOX 520, 200 BERNAL AVENUE	PITTSBURG, CA 94565
CITY OF PLEASANTON	GARY SMITH			PLEASANTON, CA 94566
PETER SHUTTS	4133 MOHR AVE #8	BUILDING OFFICIAL	100 CIVIC PLAZA	PLEASANTON, CA 94566-4750
CITY OF DUBLIN	VICTOR TAUGHER	BUILDING OFFICIAL	1 MAIN STREET, PO BOX 745	DUBLIN, CA 94568
CITY OF RIO VISTA	DONALD SULLIVAN	BUILDING OFFICIAL	1480 MAIN STREET	RIO VISTA, CA 94571
CITY OF ST. HELENA	DENNIS M HOFFMAN	1 MAIN STREET		ST. HELENA, CA 94574
CITY OF RIO VISTA	BUILDING DEPARTMENT			RIO VISTA, CA 94576
L.T. WADE COMPANY	2075 ADAMS AVENUE	P.O. BOX 1978	835 EAST 14TH STREET	SAN LEANDRO, CA 94577
ALAMEDA CO. BUILDING EXCHANGE	ATTN: ELMER EGGOLD	BUILDING OFFICIAL		SAN LEANDRO, CA 94577
CITY OF SAN LEANDRO	WILLIAM SCHOCK			SAN LEANDRO, CA 94577
GEORGE/GARY	14427 KINGS CT	BUILDING OFFICIAL	2222 CAMINO RAMON	SAN LEANDRO, CA 94578-1749
CITY OF SAN RAMON	DONALD G RHOADES	P.O. BOX 5160		SAN RAMON, CA 94583
HOME BUILDERS ASSOCIATION	OF NORTHERN CALIFORNIA			SAN RAMON, CA 94583
JONATHAN H HOUK	1414 DRIFTWOOD CIRCLE	29 ANCHOR DR.		FAIRFIELD, CA 94585
SEABREEZE M.H.P.	HAROLD GUILD	BUILDING OFFICIAL	701 CIVIC CENTER BOULEVARD	SUISUN CITY, CA 94585
SUISUN CITY	STEVEN BROWN	P.O. BOX 803		SUISUN CITY, CA 94585
WESTERN PRODUCT COMPANY	ATTN: DONALD J. MC GLINCHY	BUILDING OFFICIAL	2185 ELLIOT DRIVE	UNION CITY, CA 94587
CITY OF AMERICAN CANYON	JOE WILLER	401 NEBRASKA STREET		AMERICAN CANYON, CA 94589
PLUMBERS & PIPE FITTERS LOCAL # 343	ATTN: CAROL GRIFFIN	BUILDING OFFICIAL	PO BOX 3068, 555 SANTA CLARA ST.	VALLEJO, CA 94590
CITY OF VALLEJO	LEON MCNEIL			VALLEJO, CA 94590
PHILIP C PHILIPPS	2135 SAN MIGUEL DRIVE	COMMUNIRY DEVELOPMENT DEPT.	1666 N. MAIN STREET	WALNUT CREEK, CA 94596
CITY OF WALNUT CREEK	J.R. DICK COSTA	2135 SAN MIGUEL DRIVE		WALNUT CREEK, CA 94596
CUNSULTING ENGINEER	PHILIP PHILIPPS	BUILDING OFFICIAL	1666 NORTH MAIN STREET	WALNUT CREEK, CA 94596
CITY OF WALNUT CREEK	ROGER L SHARPE	P.O. BOX 30095		WALNUT CREEK, CA 94596
WELLS FARGO BANK	ATTN: BETTY SCOTT	2036 LIVINGSTON STREET		WALNUT CREEK, CA 94598
BROCHIER & ASSOCIATES	ALLEN BROCHIER	1717 MIDDLE HARBOR ROAD	BUILDING CODES AND SPECIAL PROJECTS	OAKLAND, CA 94606
UNION PACIFIC RAILROAD CO.	ATTN: R. B. REDUS, DIRECTOR	1111 FRANKLIN STREET 6TH FLOOR	2200 POWELL STREET, 12TH FLOOR	OAKLAND, CA 94607
ELLIE ROSS	UNIVERSITY OF CALIFORNIA	BUILDING OFFICIAL	120 VISTA AVE	OAKLAND, CA 94607-5200
CITY OF EMERYVILLE	GARY BREWEN	BUILDING OFFICIAL	120 VISTA AVENUE	EMERYVILLE, CA 94608
CITY OF PIEDMONT	CHESTER NAKAHARA	BUILDING OFFICIAL		PIEDMONT, CA 94611
CITY PIEDMONT	VINCENT J LE GRIS	360 - 17TH STREET	1330 BROADWAY, SIXTH FLOOR	PIEDMONT, CA 94611
DAVID ROTH	1 KAISER PLAZA, SUITE 601	BUILDING OFFICIAL		OAKLAND, CA 94612
S J ENGINEERS	ATTN: NEIL JOSON	300 LAKESIDE DR., 12TH FLOOR		OAKLAND, CA 94612
CITY OF OAKLAND	CLARK GERTNER	1417 CLAY ST., 3RD. FLOOR	1330 BROADWAY, 2ND FLR. RM 203	OAKLAND, CA 94612
UNIVERSITY OF CALIFORNIA	ELLIE ROSS	BLDG. OFFICIAL		OAKLAND, CA 94612
CITY OF OAKLAND PLANNING DEPT.	MS. HELAINE KAPLAN PRENTICE	7825 SAN LEANDRO STREET		OAKLAND, CA 94612
CITY OF OAKLAND	RANDALL LUM			OAKLAND, CA 94612
AMERICAN BRASS & IRON	ATTN: D. HANEL, K. WIXSON			OAKLAND, CA 94621

ASSOC. RFG. CONTR./BAY AREA CO	ATTN: J. T. BANISTER	6301 EDGEWATER DRIVE		OAKLAND, CA 94621
W.L.M.D.	ATTN: WM. R. ROHR	421 PENDLETON WAY		OAKLAND, CA 94621-2122
E B M.U.D	KURT LADENSACK	P.O BOX 29055		OAKLAND, CA 94623
CITY OF SANTA ANA	AL LAIRSON	DEPARTMENT OF BUILDING & SAFETY	P.O. BOX 1988-M19	SANTA ANA, CA 94702
DEPT. OF HEALTH SERVICES	ATTN: DAVID SPATH	2151 BERKELEY WAY		BERKELEY, CA 94704
CITY OF BERKELEY	ATTN: ROBERT GAMBLIN	2180 MILVIA STREET	2120 MILVIA STREET	BERKELEY, CA 94704
CITY OF BERKELEY	HILLARY HERMAN	BUILDING OFFICIAL		BERKELEY, CA 94704
CITY OF BERKELEY	ROBERT GAMBLIN	2180 MILVIA STREET		BERKELEY, CA 94704
BARRY ATWOOD	1260 BRIGHTON AVE. #216			BERKELEY, CA 94704
CITY OF ALBANY	MARIE TAYLOR	BUILDING OFFICIAL	1000 SAN PABLO AVE.	ALBANY, CA 94706
OFFICE OF THE GEN. COUNSEL	DAVID A DORINSON	590 UNIVERSITY HALL		ALBANY, CA 94706
UNIVERSITY OF CALIFORNIA	DOCUMENTS DEPT.	GENERAL LIBRARY		BERKELEY, CA 94720
CITY OF RICHMOND, HOUSING DEPT	ATTN: TED BURTON, DIRECTOR	330 25TH STREET		BERKELEY, CA 94720
CITY OF RICHMOND	CHARLES WOFFORD	BUILDING OFFICIAL	PO BOX 4046	RICHMOND, CA 94804
CITY OF SAN PABLO	KENNETH P HAYNES	BUILDING OFFICIAL	#1 ALVARADO SQUARE	RICHMOND, CA 94804
COUNTY OF MARIN	STEPHEN JENSEN	BUILDING OFFICIAL	3501 CIVIC CENTER DRIVE	SAN PABLO, CA 94806
CA CONF./DIRECTORS/SANITATION	WILLIAM L DESMOND	BUILDING OFFICIAL	CIVIC CENTER, ROOM 401	SAN RAFAEL, CA 94903
GEORGE BERTRAM	2140 US 101 HWY	MARIN CO. PUBLIC HLTH. DEPT.		SAN RAFAEL, CA 94903
DELENEA DIGNE	P.O. BOX 1438			GREENBRAE, CA 94904
CITY OF SAN RAFAEL	FRED VINCENTI	BUILDING OFFICIAL	P.O. BOX 15160	SAN RAFAEL, CA 94915
MARGARET AZEVEDO	1877 CENTRO WEST			SAN RAFAEL, CA 94915-1560
TOWN OF TIBURON	DEAN BLOOMQUIST	BUILDING OFFICIAL	1155 TIBURON BLVD.	TIBURON, CA 94920
CITY OF BELVEDERE	JOHN ANASTASIO	BUILDING OFFICIAL	450 SAN RAFAEL AVENUE	TIBURON, CA 94920
CITY OF CORTE MADERA	LARRY JONES	BUILDING OFFICIAL	3 P.O. BOX 159	BELVEDERE, CA 94920
CITY OF ROHNERT PARK	DANIEL LOUGE, SR.	BUILDING OFFICIAL	6750 COMMERCE BOULEVARD	CORTE MADERA, CA 94925
BORG-WARNER CHEMICALS	ATTN: A.J. LONG	P.O. BOX 26		ROHNERT PARK, CA 94928
CITY OF FAIRFAX	JIM MOSCOSO	BUILDING OFFICIAL	142 POLINAS ROAD	DILLON BEACH, CA 94929
CITY OF COTATI	RON BERGESON	BUILDING OFFICIAL	201 W SIERRA AVENUE	FAIRFAX, CA 94930
CITY OF LARKSPUR	BOB SINOTT	BUILDING OFFICIAL	400 MAGNOLIA BLVD.	COTATI, CA 94931-4217
HOUSING ASSISTANCE COUNCIL	ATTN. SUSAN PECK	1050 REDWOOD HIGHWAY		LARKSPUR, CA 94939-2035
CITY OF MILL VALLEY	DON DICKENSON	BUILDING OFFICIAL	P.O. BOX 1029	MILL VALLEY, CA 94941
ALFRED GOLDBERG	GOLDBERG RESEARCH DEVELOPMENT	110 TIBURON BLVD.		MILL VALLEY, CA 94941
CITY OF NOVATO	HARRY W GRAVES	BUILDING OFFICIAL	901 SHERMAN AVENUE	MILL VALLEY, CA 94941
CITY OF PETALUMA	JOSEPH KAGAN	BUILDING OFFICIAL	11 ENGLISH STREET, PO BOX 61	NOVATO, CA 94945
CITY OF ROSS	RABI ELIAS	BUILDING OFFICIAL	P.O. BOX 320	PETALUMA, CA 94952
CITY OF SAN ANSELMO	TONY DE SOUSA	BUILDING OFFICIAL	525 SAN ANSELMO	ROSS, CA 94957
CITY OF SAUSALITO	MERL MAURONI	BUILDING OFFICIAL	P.O. BOX 1279	SAN ANSELMO, CA 94960
RICHARD ALAND	P.O. BOX 1359			SAUSALITO, CA 94966
CITY OF CAMPBELL	FRANK MILLS	BUILDING OFFICIAL	70 NORTH FIRST STREET	APTOS, CA 95001-1359
CITY OF CAPITOLA	DANIEL J KOSTELEC	BUILDING DEPARTMENT	420 CAPITOLA AVENUE	CAMPBELL, CA 95008
CITY OF CAPITOLA	DANIEL S KOSTELEC	BUILDING OFFICIAL	420 CAPITOLA AVENUE	CAPITOLA, CA 95010
HOUSING AUTH. OF SANTA CRUZ	ROBERTO YBARRA	2180 41ST. AVE.		CAPITOLA, CA 95010
LESTER & LESTER	10050 N. WOLFE RD., RM SW2-106			CAPITOLA, CA 95010-2060
CITY OF CUPERTINO	JOE ANTONUCCI	BUILDING OFFICIAL	10300 TORRE AVENUE	CUPERTINO, CA 95014
CITY OF GILROY	DAVE CHANTLER	BUILDING OFFICIAL	7351 ROSSANA STREET	CUPERTINO, CA 95014
COUNTY OF SAN BENITO	MICHAEL M MACHADO	BUILDING OFFICIAL	3224 SOUTHSIDE ROAD	GILROY, CA 95020
SAN BENITO COUNTY BUILDING DEPARTMENT	MICHAEL MACHADO	CHIEF BUILDING OFFICIAL	3220 SOUTHSIDE ROAD	HOLLISTER, CA 95023
CITY OF HOLLISTER	THOMAS E BARRY	BUILDING OFFICIAL	375 FIFTH STREET	HOLLISTER, CA 95023
CITY OF MONTE SERENO	DONALD WIMBERLY	BUILDING OFFICIAL	18041 SARATOGA-LOS GATOS ROAD	HOLLISTER, CA 95023
CITY OF LOS GATOS	SCOTT R BAKER	BUILDING OFFICIAL	110 EAST MAIN STREET	MONTE SERENO, CA 95030
CITY OF MILPITAS	EDGAR F RODRIGUEZ	BUILDING OFFICIAL	455 EAST CALAVERAS BOULEVARD	LOS GATOS, CA 95030
CITY OF MORGAN HILL	BRIAN WASHKO	BUILDING OFFICIAL	17555 PEAK AVENUE	MILPITAS, CA 95035
CITY OF SAN JUAN BAUTISTA	MIKE CAMPBELL	BUILDING OFFICIAL	PO BOX 1420	MORGAN HILL, CA 95037
UNDERWRITERS LABORATORIES, INC	ATTN. JOSEPH BROOKS	1655 SCOTT BOULEVARD		SAN JUAN BAUTISTA, CA 95045
CITY OF SANTA CLARA	SHEILA LEE	BUILDING OFFICIAL	1500 WARBURTON AVENUE	SANTA CLARA, CA 95050
DAVID HUGH CARTER	ARCHITECT AIA	308 CLEVELAND AVENUE		SANTA CLARA, CA 95050
SANTA CRUZ COUNTY HEALTH SERVICES AGENCY	DIANE L EVANS	DIRECTOR	701 OCEAN STREET, ROOM 312	SANTA CRUZ, CA 95060
COUNTY SANTA CRUZ	JOHN DECOURCY	BUILDING OFFICIAL	701 OCEAN ST, ROOM 420	SANTA CRUZ, CA 95060
COUNTY OF SANTA CRUZ	JOHN DECOUREY	BUILDING OFFICIAL	701 OCEAN STREET, ROOM 400	SANTA CRUZ, CA 95060
SANTA CRUZ COUNTY HEALTH SERVICES AGENCY	RAY TOSHITSUNE	701 OCEAN STREET, ROOM 312		SANTA CRUZ, CA 95060
CITY OF SANTA CRUZ	RICHARD STUBENDORFF	BUILDING OFFICIAL	809 CENTER STREET, ROOM 1206	SANTA CRUZ, CA 95060
PLUMBERS & PIPE FITTERS LOCAL #365	ATTN: FRED RULE, JR.	2920 SOQUEL AVE.		SANTA CRUZ, CA 95060
CITY OF SCOTTS VALLEY	ROBERT COSTA	BUILDING OFFICIAL	1 CIVIC CENTER DRIVE	SANTA CRUZ, CA 95062
KEITH MILLER	225 MT. HERMON RD.			SCOTTS VALLEY, CA 95066
WATERSAVER SUPPLY	GARY G SMITH	P.O. BOX 2682		SCOTTS VALLEY, CA 95066-4020
CITY OF SARATOGA	JOSEPH S ONCAY	BUILDING OFFICIAL	13777 FRUITVALE AVENUE	SARATOGA, CA 95070
DENNIS MILLER CONSTRUCTION CO	DENNIS MILLER	961 BREWINGTON CT.		SARATOGA, CA 95070
DENNIS MILLER CONSTRUCTION CO.	DENNIS MILLER	961 BREWINGTON CT.	PO BOX 50000, 250 MAIN ST.	WATSONVILLE, CA 95076
CITY OF WATSONVILLE	RAFAEL ADAME	BUILDING OFFICIAL		WATSONVILLE, CA 95076
SAN JOSE BUILDING DEPT.	ANDREW ADLEMAN	801 N. FIRST ST., RM 200	801 N. FIRST ST.	WATSONVILLE, CA 95076
SANTA CLARA CO. FIRE CHIEFS	ATTN: ALAN CARDER	70 W. HEDDING STREET		SAN JOSE, CA 95110
CITY OF SAN JOSE	BOB ADLER	BUILDING OFFICIAL		SAN JOSE, CA 95110
SANTA CLARA CO. HOUSING AUTHORITY	GHIDOSSI BILL	505 WEST JULIAN STREET		SAN JOSE, CA 95110
MATTEONI, SAXE & NANDA	MARGARET ECKER NANDA	1740 TECHNOLOGY DRIVE, SUITE 250		SAN JOSE, CA 95110
				SAN JOSE, CA 95110

CITY OF SAN JOSE, BUILDING DEPT.	ROBERT EPSTEIN	CUST SVC, CHIEF BLDG INSPECTOR	801 N. FIRST ST., ROOM 200	SAN JOSE, CA 95110
COUNTY OF SANTA CLARA	TOM SHIH	BUILDING OFFICIAL	70 W. HEDDING ST, 7TH FLOOR	SAN JOSE, CA 95110
BLDG. IND ASSN. OF NO. CALIF	SOUTH BAY DIVISION	181 METRO DRIVE #580		SAN JOSE, CA 95110-1317
PLUMBERS & PIPE FITTERS LOCAL #393	ATTN: ROBERT DUFFEY	370 UMBARGER RD		SAN JOSE, CA 95111
PLMBRS/STEAMFITTERS LOCAL #393	ATTN: ROBERT J. DUFFEY	370 UMBARGER ROAD		SAN JOSE, CA 95111
PLUMBERS & STEAMFITERS LOCAL #393	ATTN: ROBERT J DUFFEY	370 UMBARGER ROAD		SAN JOSE, CA 95111
PLUMBERS & STEAMFITTERS LOCAL #393	ATTN. ROBERT J. DUFFEY	370 UMBARGER ROAD		SAN JOSE, CA 95111
BUSINESS MANAGER	LOYD WILLIAMS	FINANCIAL SECRETARY-TREASURER	370 UMBARGER ROAD	SAN JOSE, CA 95111-2033
ENCHECK	ATTN. BOB NOREN	1440 KOLL CIRCLE, SUITE 102		SAN JOSE, CA 95112
ENCHECK	BOB NOREN	1440 KOLL CIRCLE, STE.102		SAN JOSE, CA 95112
GSMOL	DAVE HENNESSY	3381 STEVENS CREEK BOULEVARD		SAN JOSE, CA 95117
THE ABS INSTITUTE	ATTN. RUSSELL B. GREEN, DIR.	6477 CRYSTAL SPRING DRIVE		SAN JOSE, CA 95120
SAN JOSE FIRE DEPARTMENT	ATTN: DAN BOURDON	1205 HERMOSA WAY		SAN JOSE, CA 95125
DORIS SPECKT	#6 LINDSAY STREET	BUILDING OFFICIAL	6 EAST LINDSAY STREET	STOCKTON, CA 95202
CITY OF STOCKTON	DALE HIMES	DIRECTOR	304 E WEBER AVENUE, THIRD FLOOR	STOCKTON, CA 95202
SAN JOAQUIN COUNTY PUBLIC HEALTH SERVICE	DONNA HERAN	304 WEBER AVENUE, THIRD FLOOR		STOCKTON, CA 95202
SAN JOAQUIN COUNTY PUBLIC HEALTH SERVICE	MARK BARCELLOS	3935 CORORNAD AVE.		STOCKTON, CA 95202
PLUMBERS & PIPE FITTERS LOCAL #492	ATTN: JOE WINSTEAD	1810 E. HAZELTON AVE.	1810 EAST HAZELTON AVENUE	STOCKTON, CA 95204
CHIEF BUILDING OFFICIAL	COUNTY OF SAN JOAGUIN	BUILDING OFFICIAL	P.O. BOX 667	STOCKTON, CA 95205
COUNTY OF SAN JOAQUIN	JERRY HERZICK	BUILDING OFFICIAL		STOCKTON, CA 95205
CITY OF ANGELS CAMP	JOHN J PARGETT	18812 MONTAVISTA STREET	217 W ELM ST	ANGELS CAMP, CA 95222
CHERRY GROWERS ASSOCIATION	ATTN: FRANCIS BOGNUDA	FIRE INSPECTOR	CITY HALL, 221 WEST PINE STREET	LINDEN, CA 95236
CITY OF LODI FIRE DEPARTMENT	KATHLEEN GAST	BUILDING OFFICIAL	891 MOUNTAIN RANCH ROAD	LODI, CA 95240
CITY OF LODI	ROGER G HOUS	BUILDING OFFICIAL	891 MOUNTAIN RANCH RD.	LODI, CA 95240
CITY OF SAN ANDREAS	RAY WALLER	BUILDING OFFICIAL	750 BELLEVUE ROAD	SAN ANDREAS, CA 95249
COUNTY OF CALAVERAS	RAYMOND T WALLER	BUILDING OFFICIAL	2220 MAGNOLIA STREET	SAN ANDREAS, CA 95249
CITY OF ATWATER	TONY ALTFELD	BUILDING OFFICIAL	2220 MAGNOLIA AVENUE	ATWATER, CA 95301
CITY OF CERES	MICHELLE FRANK	BUILDING DEPARTMENT	P.O. BOX 248	CERES, CA 95307
CITY OF CERES	STEVE BAIS	BUILDING OFFICIAL	P.O. BOX 306, 682 THIRD AVENUE	CERES, CA 95307
CITY OF ESCALON	THOMAS E CLARK	BUILDING OFFICIAL	7018 PINE STREET, P.O. BOX 9	ESCALON, CA 95320
CITY OF GUSTINE	DAVID K WITTER	BUILDING OFFICIAL	18775 HOWLAND RD., STE 1	GUSTINE, CA 95322
CITY OF HUGHSON	RON BREMER	CHIEF BUILDING INSPECTOR	P.O. BOX 308, 1416 C STREET	HUGHSON, CA 95326
CITY OF LATHROP	MATT BROWNE	BUILDING OFFICIAL	1001 WEST CENTER STREET	LATHROP, CA 95330
CITY OF LIVINGSTON	PETE ALEXANDER	BUILDING OFFICIAL	P.O. BOX 1268	LIVINGSTON, CA 95334
CITY OF MANTECA	JOE MEATH	BUILDING OFFICIAL	777 WEST 22ND STREET	MANTECA, CA 95336
COUNTY OF MARIPOSA	JOHN E DAVIS	DIRECTOR	2222 M STREET	MARIPOSA, CA 95338
MERCED COUNTY ENVIRONMENTAL HEALTH	JEFF H PALSGAARD	BUILDING OFFICIAL	678 WEST 18TH	MERCED, CA 95340
COUNTY OF MERCED	RICHARD S GRAVES	BUILDING OFFICIAL		MERCED, CA 95340
CITY OF MERCED	STEVE PATTERSON	STANISLAUS COUNTY	1718 MORGAN ROAD	MERCED, CA 95340
DONALD GONSALVES	213 PHILLIP COURT	BUILDING DEPARTMENT	P.O. BOX 642	MODESTO, CA 95350
SR. ENVIROMENTAL HEALTH SPECIALIST	JIM SELLER	BUILDING OFFICIAL	P.O. BOX 642	MODESTO, CA 95351-5894
CITY OF MODESTO	BOB GAGLIARDI	604 10TH STREET		MODESTO, CA 95353
CITY OF MODESTO	DARYL WILLEY	BUILDING INSPECTION DIVISION	1100 H STREET	MODESTO, CA 95353
PLUMBERS & PIPE FITTERS LOCAL #437	ATTN: LESLIE MAY MODESTO LABOT TEMPLE	DEPUTY BUILDING OFFICIAL	1010 10TH STREET	MODESTO, CA 95354
STANISLAUS COUNTY PUBLIC WORKS	ED ANDRADE	DIRECTOR		MODESTO, CA 95354
COUNTY OF STANISLAUS	GEORGE ANDRADE	3800 CORNUCOPIA WAY, SUITE C	3800 CORNUCOPIA WAY, SUITE C	MODESTO, CA 95354
SIGNATURE POOLS	3200 SISK RD., SUITE D	BUILDING OFFICIAL		MODESTO, CA 95356
STANISLAUS COUNTY	GORDON M DEWERS	BUILDING OFFICIAL	280 NORTH THIRD AVENUE	MODESTO, CA 95358-9492
STANISLAUS COUNTY ENVIRONMENTAL RESOURCE	JIM SELLERS	CITY OF PATTERSON, BUILDING DEPARTMENT	P.O. BOX 667, 344 W. LAS PALMAS	MODESTO, CA 95358-9492
CITY OF OAKDALE	DAVID L LEVIS		P.O. BOX 667	OAKDALE, CA 95361
CITY OF PATTERSON	DAVID A RANDALL	BUILDING OFFICIAL		PATTERSON, CA 95363
SR. ENV. HEALTH SPECIALIST	JIM SELLER	BUILDING OFFICIAL	259 NORTH WILMA AVENUE	PATTERSON, CA 95363
DESIGNED MOBILE SYSTEMS	P. O. BOX 367	BUILDING OFFICIAL	6707 THIRD STREET	PATTERSON, CA 95363
FLORA MARTINEZ	P. O. BOX 475	BUILDING OFFICIAL	#2 SOUTH GREEN STREET	PLANADA, CA 95365
RICHARD L MILLER	196 TIFFANY CIRCLE	BUILDING OFFICIAL	94 NORTH WASHINGTON STREET	RIPON, CA 95366
CITY OF RIPON	TED JOHNSTON	BUILDING OFFICIAL		RIPON, CA 95366
CITY OF RIVERBANK	BOB ZIPF	BUILDING OFFICIAL	520 TRACY BOULEVARD	RIVERBANK, CA 95367
COUNTY OF TUOLUMNE	GREGORY LAMB	BUILDING OFFICIAL		SONORA, CA 95370
CITY OF SONORA	JIM MITCHELL	BUILDING OFFICIAL	156 S. BROADWAY, SUITE 130	SONORA, CA 95370
JOHN C SANTNER	355 W GRANTLINE RD	BUILDING OFFICIAL	PO BOX 199	TRACY, CA 95376
CITY OF TRACY	J. TEIG	BUILDING OFFICIAL		TRACY, CA 95376
MRS. JERRY BROWN	1047 TORNELL DRIVE	75 WESTGATE CIRCLE	P.O. BOX 1678	TURLOCK, CA 95380
CITY OF TURLOCK - BLDG. & SAFETY DIV.	MARK ELLIS	BUILDING OFFICIAL	2550 VENTURA AVENUE	TURLOCK, CA 95380-5435
CITY OF WATERFORD	JAMES P FRITZINGER	BUILDING OFFICIAL		WATERFORD, CA 95386
L	1130 ADRIENNE CT.	1440 GUERNEVILLE RD.		SANTA ROSA, CA 95401
DORIS M CROWTHER	VALLE VISTA ADULT SUBDIVISION			SANTA ROSA, CA 95401
CITY OF SANTA ROSA	WILLIAM E MYERS	3313 CHANATE ROAD		SANTA ROSA, CA 95402
COUNTY OF SONOMA	ERIC MAYS	2559 TACHEVAH DRIVE		SANTA ROSA, CA 95403
SONOMA COUNTY HOUSING AUTHORITY	ATTN: PAUL TURNER	P.O. BOX 6025		SANTA ROSA, CA 95403-4107
JAMES HARRISON	1000 MCDONALD AVENUE			SANTA ROSA, CA 95404
THOMAS WEISSBLUTH	1822 ARBOR AVENUE			SANTA ROSA, CA 95404
SONOMA COUNTY HEALTH OFFICER	ATTN: ROBERT L. HOLTZER, M.D.			SANTA ROSA, CA 95404
LEAGUE OF WOMEN VOTERS OF	SANTA ROSA			SANTA ROSA, CA 95405
NORTH COAST BUILDER EXCHANGE	ATTN: LEN S. SILVA			SANTA ROSA, CA 95406

ROGER DUVALL	2800 SANTA ROSA AVE			SANTA ROSA, CA 95407
MICHAEL CHARLEY	461 BEJAY AVENUE			SANTA ROSA, CA 95407
MICHAEL CHARLEY	462 BEJAY AVE			SANTA ROSE, CA 95407
RESIDENTIAL HOMES, INC.	TONY GHAJAR			SANTA ROSA, CA 95407
PLUMBERS LOCAL #159	LARRY L ALLEN			CONCORCD, CA 95421
CITY OF CLOVERDALE	FREDERICK L BROWNE			CLOVERDALE, CA 95425
RON GUENTHER	29900 HIGHWAY 20			FORT BRAGG, CA 95437
CITY OF HEALDSBURG	STEVE LAMB			HEALDSBURG, CA 95448-0578
COUNTY OF LAKE	CRAIG OLIVER			LAKEPORT, CA 95453
CITY OF LAKEPORT	ROBERT HOWE			LAKEPORT, CA 95453
CITY OF LAKEPORT	ROBERT HOWE			LAKEPORT, CA 95453
CITY OF POINT ARENA	RONALD F FELLMAN			PORT ARENA, CA 95468
CITY OF SEBASTOPOL	FRED CARD			SEBASTOPOL, CA 95472
NORTH BAY HYDRONICS	P.O. BOX 478			SONOMA, CA 95476
CITY OF SONOMA	WAYNE WYRICK, JR.			SONOMA, CA 95476
COUNTY OF MENDOCINO	CHRIS WARRICK			UKIAH, CA 95482
CITY OF UKIAH	CLIF SHEPARD			UKIAH, CA 95482
BUILIDNG INSPECTOR	CLIFF SHEPARD			UKIAH, CA 95482
MENDOCINO COUNTY WATER AGENCY	COUNTY COURTHOUSE			UKIAH, CA 95482
CITY WILLITS	FRAMK W HOWARD			WILLITS, CA 95490
MICHAEL LIGHTRAIN	P.O. BOX 69			WILLITS, CA 95490
CITY OF WINDSOR	BILL SHARKEY			WINDSOR, CA 95492
CLINT SWABSON	1545 SWANSON LANE			EUREKA, CA 95501
PLUMBERS & PIPE FITTERS LOCAL #471	ATTN: H. G. HABERMAN			EUREKA, CA 95501
COUNTY OF HUMBOLDT	TODD SOBOLIK			EUREKA, CA 95501
CITY OF EUREKA	BOYD DAVIS			EUREKA, CA 95501-1185
VROMAN ENGINEERIG	TRUEMAN VROMAN			EUREKA, CA 95501-4334
CITY OF ARCATA	DEAN R RENFER			ARCATA, CA 95521
CITY OF BLUE LAKE	RAY SCHWABENLAND			BLUE LAKE, CA 95525
CITY OF CRESCENT CITY	DONALD OLSON			CRESCENT CITY, CA 95531
DIRECTOR OF BUILDING & PLANNING	ERNEST PERRY			CRESCENT CITY, CA 95531
DEL NORTE CO., BUILDING DEPT.	ERNIE PERRY			CRESCENT CITY, CA 95531
COUNTY OF DEL NORTE	STAN MORRIS			CRESCENT CITY, CA 95531
CITY OF FERNDALE	RAY SCHWABENLAND			FERNDALE, CA 95536
CITY OF FORTUNA	RICHARD A BENNETT			FORTUNA, CA 95540
CITY OF RIO DELL	WAYNE MAYHALL			RIO DELL, CA 95562
CITY OF TRINIDAD	DON BOLTZEN			TRINIDAD, CA 95570
PLACER COUNTY BUILDING DEPT.	ED JENKINS			AUBURN, CA 95603
COUNTY OF PLACER	ED JENKINS			AUBURN, CA 95603
MINTA ARCHITECTURE	JERRY MINTA			AUBURN, CA 95603
CITY OF AUBURN	WAYNE A WHITE			AUBURN, CA 95603
AMER. IRON & STEEL INSTITUTE	11899 EDGEWOOD RD. STE. G			AUBURN, CA 95603-3437
PAINTING & DECORATING	CONTRACTORS OF CALIFORNIA			CARMICHAEL, CA 95608
PAINTER PLUMBING, INC.	ATTH: ROBERT H. PAINTER			CARMICHAEL, CA 95608-3814
WILLIAM H MERWIN	ROUTE 1 BOX 422			CLARKSBURG, CA 95612
UNIVERSITY OF CALIFORNIA, DAVIS	ATTN: DON BROWN			DAVIS, CA 95616
ARCHITECT	AUBREY MOORE, JR.			DAVIS, CA 95616
CITY OF DAVIS	LORIN GARDNER			DAVIS, CA 95616
MADONOYH, HOLLAND & ALLEN	ATTN. SETH MERENITZ			SACRAMENTO, CA 95618
BUILDING OFFICIAL	CITY OF DIXON			DIXON, CA 95620
CITY OF DIXON	PAUL SIEGEL			DIXON, CA 95620
AMERISPEC HOME INSPECTION SERVICE	GARY DACUS			CITRUS HEIGHTS, CA 95621-5418
LAND HOME FINANCIAL SERVICES	4401 HAZEL AVE., SUITE 265			FAIR OAKS, CA 95628
FAVRO, MC LAUGHLIN & ASSOC.	ATTN: PAT MC LAUGHLIN			FAIR OAKS, CA 95628
CITY OF FOLSOM	MARVIN MAY			FOLSOM, CA 95630
CITY OF FOLSOM	MICHAEL A RODRIQUEZ			FOLSOM, CA 95630
CITY OF GALT	AL GOSS			GALT, CA 95632-1050
COUNTY OF MADERA	MICHAEL KIRN			MADERA, CA 95637
PERRY A EARL	BROKER/OWNER			IONE, CA 95640
CITY OF ISLETON	CARL HENDREN			ISLETON, CA 95641
COUNTY OF AMADOR	JAY STUDER			JACKSON, CA 95642
CITY OF PLYMOUTH	JOHN SOUSA			PLYMOUTH, CA 95642
CITY OF JACKSON	WATSON S CLIFFORD			JACKSON, CA 95642
CITY OF LOOMIS	JIM SCHELL			LOOMIS, CA 95650
GARY DOUPNIK MFG., INC.	P.O. BOX 527, 3415 SWETZER RD.			LOOMIS, CA 95650
COUNTY OF EL DORADO	BILL CAREY			PLACERVILLE, CA 95667
CITY OF PLACERVILLE	CONRAD MONTGOMERY			PLACERVILLE, CA 95667
CITY OF PLACERVILLE	JACK S ATKINS			PLACERVILLE, CA 95667
BUILDING OFFICIAL	MR. JACK ATKINS			PLACERVILLE, CA 95667
CARLSON ALUMINUM PRODUCTS	3909-A SECURITY PARK DRIVE			RANCHO CORDOVA, CA 95670
AMIGAS PROPANE INC.	11030 WHITE ROCK RD. #100			RANCHO CORDOVA, CA 95670-6010
ROBERT W HALL	5461 LAKES END DRIVE			ROCKLIN, CA 95677
CITY OF ROCKLIN	PETE GUISASOLA			ROCKLIN, CA 95677
CITY OF ROSEVILLE	JOHN A KINTZ			ROSEVILLE, CA 95678

CITY OF ROSEVILLE	LAWRENCE F LEONARD	SR. BUILDING PLANS CHECKER	321 VERNON STREET	ROSEVILLE, CA 95678
JAMES R HENSON	4700 OLD FRENCH TOWN ROAD, SPACE 1			SHINGLE SPRINGS, CA 95682
CITY OF AMADOR	JAMES S DORRIS	BUILDING OFFICIAL	P.O. BOX 182	SUTTER CREEK, CA 95685
CITY OF SUTTER CREEK	JEFFREY KELLEY	BUILDING OFFICIAL	18 MAIN STREET	SUTTER CREEK, CA 95685
CITY OF VACAVILLE	WILLIAM S TURGEON	BUILDING OFFICIAL	605 MERCHANT STREET, CITY HALL	VACAVILLE, CA 95688
ASSOCIATED GENERAL CONTRACTORS	OF CALIFORNIA	3095 BEACON BOULEVARD		WEST SACRAMENTO, CA 95691
ASSOCIATED GENERAL CONTRACTORS	OF CALIFORNIA	3095 BEACON BOULEVARD		WEST SACRAMENTO, CA 95691
TECON PACIFIC	1980 S. RIVER ROAD			WEST SACRAMENTO, CA 95691
CITY OF WEST SACRAMENTO	BHU PATEL P.E.	BUILDING OFFICIAL	1951 S. RIVER RD.	WEST SACRAMENTO, CA 95691
BHU PATEL PLAN INC.	CITY OF WEST SACRAMENTO	1551 SOUTH RIVER ROAD		W. SACRAMENTO, CA 95691
CITY OF WHEATLAND	JIM MCANINCH	BUILDING OFFICIAL	P.O. BOX 395	WHEATLAND, CA 95692
CITY OF WINTERS	JOAN THISSEL	BUILDING OFFICIAL	CITY HALL 318 FIRST STREET	WINTERS, CA 95694
YOLO CO. BUILDING DEPT.	292 W. BEAMER ST.			WOODLAND, CA 95695
CALIFORNIA PIPE TRADES COUNCIL	ATTN: JOHN P. GORMAN	614 GIBSON ROAD		WOODLAND, CA 95695
CA. PIPE TRADES COUNCIL	ATTN; JOHN P. GORMAN	614 GIBSON ROAD		WOODLAND, CA 95695
COUNTY OF YOLO	BRETT HALE	BUILDING OFFICIAL	292 WEST BEAMER STREET	WOODLAND, CA 95695
MR. JOHN P. GORMAN	CALIFORNIA PIPE TRADES COUNCIL	614 GIBSON ROAD		WOODLAND, CA 95695
CITY OF WOODLAND	JANET RUGGIERO	BUILDING OFFICIAL	300 FIRST STREET	WOODLAND, CA 95695
BAYSHORE HOMES OF CALIF., INC.	P. O. BOX 1427			WOODLAND, CA 95695
SIMPSON DURA-VENT	DONALD M TOWNSEND	CORPORATE EXECUTIVE OFFICER	877 COTTING COURT	WOODLAND, CA 95695
SIERRA PACIFIC IND.	MIKE BALDWIN	P.O. BOX 1570		VACAVILLE, CA 95696-1510
CITY OF COLFAX	BOB CARTON	BUILDING DEPARTMENT	P.O. BOX 702	VACAVILLE, CA 95696-1570
CITY OF COLFAX	BOB CARTON	BUILDING OFFICIAL	P.O. BOX 702	COLFAX, CA 95713
GOLDEN STATE SOLES	VON BASHER	2880 SUNRISE BLVD. STE. 219		COLFAX, CA 95713
HLTH. OFFICERS ASSN. OF CALIF.	CALIF. CONF. LOCAL HLTH. OFF.	5050 LAGUNA BLVD 112-580		RANCHO CORDOVA, CA 95742-6549
FRITZ LINGNAU	2486 STARMOUNT WAY			ELK GROVE, CA 95758-4151
SACRAMENTO BUILDER'S EXCHANGE	ATTN: JAMES E. LAMBERT	P.O. BOX 1462		EL DORADO HILLS, CA 95762
SACRAMENTO BUILDERS EXCHANGE	ATTN: JAMES E. LAMBERT	P.O. BOX 1462		SACRAMENTO, CA 95807
SACRAMENTO BUILDER'S EXCHANGE	ATTN: MAMES E. LAMBERT	P.O. BOX 1462		SACRAMENTO, CA 95807
AGRICULTURAL COUNCIL OF CALIF.	ATTN: CALVIN E. ADAMS	P. O. BOX 1712		SACRAMENTO, CA 95807
AGRICULTURAL COUNCIL OF CALIF.	ATTN: LELAND H. RUTH	P. O. BOX 1712		SACRAMENTO, CA 95808
CAHHS	KATHY PROCIDA	LEGISLATIVE ADVOCATE		SACRAMENTO, CA 95808
CAHHS	ROGER RICHTER	SENIOR VICE PRESIDENT		SACRAMENTO, CA 95812-1100
SAC. MUNICIPAL UTILIES DIST.	P.O. BOX 15830		POST OFFICE BOX 1100	SACRAMENTO, CA 95812-1100
ASSEMBLY.OFFICE OF RESEARCH	1020 N STREET, ROOM 408		POST OFFICE BOX 1100	SACRAMENTO, CA 95813
CA. BLDG. INDUSTRY ASSOCIATION	1107 9TH ST., SUITE 1060			SACRAMENTO, CA 95814
CA. BUILDING INDUSTRY ASSN.	1107 9TH ST., SUITE 1060			SACRAMENTO, CA 95814
LEAGUE OF CALIFORNIA CITIES	1400 K STREET			SACRAMENTO, CA 95814
ENVIRONMENTAL COUNCIL OF SACRAMENTO	909 12TH STREET			SACRAMENTO, CA 95814
MR. TIM SULLIVAN	927 - 10TH STREET			SACRAMENTO, CA 95814
C. ENGINEERING	ATTN: CAL JEPSEN	4020 EL CAMINO AVE., SUITE D-1		SACRAMENTO, CA 95814
ST. ATTORNEY GENERAL'S OFFICE	ATTN: EDNA WALZ	1515 K STREET, SUITE 511		SACRAMENTO, CA 95814
DEPT OF HEALTH SRVCS/ENVIRONMENTAL HLTH	ATTN: J. DAVE QUINTON	714 P STREET, ROOM 692		SACRAMENTO, CA 95814
DEPT. OF HEALTH SERVICES	ATTN: J. DAVE QUINTON	714 P STREET, ROOM 692		SACRAMENTO, CA 95814
ENVIRON. HEALTH/HLTH. SERVICES	ATTN: J. DAVE QUINTON	714 P STREET, ROOM 692		SACRAMENTO, CA 95814
OFFICE ENVIRON. HLTH. PROGRAMS	ATTN: J. DAVID QUINTON	714 P STREET, ROOM 692		SACRAMENTO, CA 95814
CALIF. FARM BUREAU FEDERATION	ATTN: J. ROY GABRIEL	11TH & L BUILDING, ROOM 626		SACRAMENTO, CA 95814
ST. BUILDING & CONSTRUCTION TRADES CNCL	ATTN: JAMES S. LEE	921 11TH STREET., SUITE 701		SACRAMENTO, CA 95814
CITY OF LOS ANGELES	ATTN: JILL PASCAL, LEG. REP.	1400 K STREET, ROOM 308		SACRAMENTO, CA 95814
A.E. DAVIS AND COMPANY	ATTN: LEROY E. LYON, JR.	925 L STREET, SUITE 390		SACRAMENTO, CA 95814
SACRAMENTO BUILDING INSPECTION DIVISION	ATTN: RON PECCI, CHIEF INSPECTOR	1231 I STREET 2ND FLOOR		SACRAMENTO, CA 95814
ASSEMBLY OFFFICE OF RESEARCH	ATTN: SANDY MALOS	STATE CAPITOL		SACRAMENTO, CA 95814
DEPT OF HOUSING AND COMMUNITY DEVELOP.	ATTN: TOM INFUSINO	1800 THIRD STREET		SACRAMENTO, CA 95814
STATE BUILDING STANDARDS COMMISSION	ATTN: TOM MORRISON	915 CAPITOL MALL, ROOM 200		SACRAMENTO, CA 95814
COUNTY SUPERVISORS ASSN OF CA	ATTN: VICTOR POTTORFF	1100 K STREET, SUITE 101		SACRAMENTO, CA 95814
CALIFORNIA HOUSING COUNCIL	ATTN: JACK FLANIGAN	1225 8TH STREET		SACRAMENTO, CA 95814
CO. SUPERVISORS ASSN. OF CA.	ATTN: JONI LOW, LEGIS. REP.	1100 K STREET, SUITE 101		SACRAMENTO, CA 95814
CA. BLDG. INDUSTRY ASSOCIATION	ATTN: R.H. RIVINIUS	1107 9TH STREET., SUITE 1060		SACRAMENTO, CA 95814
WMA	ATTN: SHEILA DEY	455 CAPITOL MALL, SUITE 800		SACRAMENTO, CA 95814
CO.SUPERVISORS ASSN OF CALIFORNIA	C	ATTN: VIC POTTORFF		SACRAMENTO, CA 95814
AMERICAN INST. OF ARCHITECTS	CALIFORNIA COUNCIL	1303 J STREET, SUITE 200		SACRAMENTO, CA 95814
AMERICAN INSTITUTE OF ARCHITECTS-	CALIFORNIA COUNCIL	1303 J STREET, SUITE 200		SACRAMENTO, CA 95814
DEPT OF HEALTH SERVICES OFFICE OF	DAVID QUINTON	ENVIRONMENTAL HEALTH PROGRAMS	714 P. STREET, ROOM 692	SACRAMENTO, CA 95814
CAL ST. PIPE TRADE CENTER	DENNIS GIFFORD	BUSINESS MANAGER FINANCIAL SECTION	915 L STREET, SUITE 1240	SACRAMENTO, CA 95814
CITY OF SACRAMENTO	DONALD L SCHULTZE	BUILDING OFFICIAL	827 7TH STREET, ROOM 102	SACTO, CA 95814
COUNTY OF SACRAMENTO	DONALD L SCHULTZE	BUILDING OFFICIAL	827 7TH STREET. ROOM 102	SACRAMENTO, CA 95814
CBIA	DOUG MAROHN	1107 NINTH STREET, SUITE 1060		SACRAMENTO, CA 95814
CALIF. BUILIDNG INDUSTRY ASSOCIATION	DWIGHT HANSEN	1107 NINTH STREET, SUITE 1060		SACRAMENTO, CA 95814
CA. MFD. HOUSING INSTITUTE	FRANK MURPHY, JR.	1127 11TH ST., STE. 234		SACRAMENTO, CA 95814
MS. DEAN MISCZYNSKI	GOVERNOR'S OFFICE OF PLANNING	1400 TENTH STREET		SACRAMENTO, CA 95814
THE STATE ASSEMBLY	HONORABLE TERESA HUGHES	STATE CAPITOL BLDG., ROOM 4112		SACRAMENTO, CA 95814
THE STATE SENATE	HONORABLE WILLIAM CRAVEN	STATE CAPITOL BLDG., ROOM 3070		SACRAMENTO, CA 95814
COUNTY SUPERIVSORS ASSOCIATION	OF CALIFORNIA	1100 K STREET, STE. 101		SACRAMENTO, CA 95814
FEDERAL HSG. ADMINISTRATION	PHILLIP KEITH	HOUSING & URBAN DEVELOPMENT	777 - 12TH STREET, SUITE 200	SACRAMENTO, CA 95814

E D.D.	RALPH O. LARA, MONITOR ADVOC.	800 CAPITOL MALL		SACRAMENTO, CA 95814
OFFICE OF STATEWIDE HEALTH	RICH HOISINGTON	PLANNING & DEVELOPMENT	1600 9TH STREET, ROOM 410	SACRAMENTO, CA 95814
CHIEF BUILDING INSPECTOR	SACRAMENTO CO. BUILDING DEPARTMENT	827 - 7TH STREET		SACRAMENTO, CA 95814
MR. LEO T. GOTO, ASST. DIRECTOR	SACRAMENTO HOUSING & REDEV. AGENCY	630 I STREET		SACRAMENTO, CA 95814
WMA	SHEILA DEY	1007 7TH ST. SUITE 300		SACRAMENTO, CA 95814
CA. BLDG. INDUSTRY ASSN.	TECHNICAL DIRECTOR	1107 9TH ST., SUITE 1060		SACRAMENTO, CA 95814
SACRAMENTO COUNTY PLANNING AND COMM. DEV	TOM HUTCHINGS	DIRECTOR	827 7TH STREET, ROOM 230	SACRAMENTO, CA 95814
STATE BLDG. & CONSTRUCTION	TRADES COUNCIL OF CA	921 - 11TH STREET, SUITE 701		SACRAMENTO, CA 95814
S M A.C.N.A.	ATTN: PHILIP VERMEULEN	1020 12TH STREET #101		SACRAMENTO, CA 95814
STATE BUILDING & CONSTRUCTION TRADES	COUNCIL OF CALIFORNIA	921 - 11TH ST., SUITE 400		SACRAMENTO, CA 95814-3917
CONNERLY & ASSOCIATES	2215 21ST STREET			SACRAMENTO, CA 95814-882
FARM EMPLOYERS LABOR SERVICE	ATTN: GEORGE DANIELS, III	1601 EXPOSITION BOULEVARD		SACRAMENTO, CA 95815
SACRAMENTO VALLEY APT. ASSN., INC.	221 LATHROP WAY #M			SACRAMENTO, CA 95815
SACRAMENTO VALLEY APARTMENT ASSN., INC.	221 LATHROP WAY #M			SACAMENTO, CA 95815-4215
MORTON & PITALO, INC.	JOHN PITALO	1788 TRIBUTE ROAD, #200		SACRAMENTO, CA 95815-4215
MR. ROBIN AURELIUS	MR. ROBIN AURELIUS	3279 D STREET		SACRAMENTO, CA 95815-4402
CALIFORNIA BUILDING OFFICIALS	2215 - 21ST STREET			SACRAMENTO, CA 95816
RURAL COMMUNITY ASSIST. CORP.	ATTN: CHUCK PRINCE	2125 - 195TH STREET, SUITE 263		SACRAMENTO, CA 95818
RURAL COMMUNITYASSISTANCE CORP.	ATTN: CHUCK PRINCE	2125 - 19TH STREET, SUITE 263		SACRAMENTO, CA 95818
CONNERLY AND ASSOCIATES	ATTN: JOHN MEYER	2214 - 21ST STREET		SACRAMENTO, CA 95818
RURAL COMMUNITY ASSISTANCE CORP.	ATTN: MR. GREGG SPARKS	2125 19TH STREET, SUITE 263		SACRAMENTO, CA 95818
CONNERLY & ASSOCIATES	ATTN: PAT MC LAFFERTY	2215 - 21ST STREET		SACRAMENTO, CA 95818
CONNERLY & ASSOCIATES, INC.	ATTN: PAT MC LAFFERTY	2215 - 21ST STREET		SACRAMENTO, CA 95818
CA. BUILDING OFFICIALS	CONNERLY & ASSOCIATES EXEC OFF	2215 21ST STREET		SACRAMENTO, CA 95818
CALIFORNIA BUILDING OFFICIALS	MR. CHARLES DYER	2215 21ST. STREET		SACRAMETN;O, CA 95818
PLUMBERS & PIPE FITTERS	ATTN: M.J. ROTZ LOCAL UNION #447	5841 NEWMAN COURT		SACRAMENTO, CA 95818
PLUMBERS & PIPE FITTERS LOCAL #447	ATTN: WM. RHOTEN	5841 NEWMAN CT.		SACRAMENTO, CA 95819
PLMBRS & PIPEFITTERS LOCAL 447	ATTN: WM. C. RHOTEN, BUS. MANAGER	5841 NEWMAN COURT		SACRAMENTO, CA 95819
SACRAMENTO AREA OFFICE FIGHTERS	W. HARBOLT	LOCAL 522, IAF, AFL-CIO		SACRAMENTO, CA 95819
NATL. ELECTRICAL CONTRACTORS ASSN.	ATTN: KENNETH CARLSON	7500 14TH AVENUE, #25	3101 STOCKTON BLVD.	SACRAMENTO, CA 95820
W W ADAMSON	3301 BRYANT CIRCLE			SACRAMENTO, CA 95820-3560
PACIFIC CONSULTING ENGINEERS	4020 EL CAMINO AVE., STE. A-2			SACTO, CA 95821
CMJ ENGINEERING, INC.	4020 EL CAMINO AVE., STE. B-1			SACRAMENTO, CA 95821
CMJ ENGINEERING, INC	ATTN: CAL JEPSEN	4020 EL CAMINO AVE., STE. B-1		SACRAMENTO, CA 95821
C M J. ENGINEERING, INC.	CALVIN JEPSEN	4020 EL CAMINO AVE., STE D-4		SACRAMENTO, CA 95821
MARCIA GRANT	7573 EDDY LEE WAY			SACRAMENTO, CA 95821
BLOMBERG WINDOW SYSTEMS	ATTN: JEROME BLOMBERG	P.O. BOX 22485		SACRAMENTO, CA 95822
CA. MULTIPLE LISTING SERVICE	ATTN: SHARON HILKE, LEG. ADV.	1408 CLAREMONT WAY		SACRAMENTO, CA 95822
STATE FIRE MARSHALL	ATTN: HUGH COUNCEL	7171 BOWLING DR., SUITE 600		SACRAMENTO, CA 95822
CALIFORNIA HORSE RACING BOARD	1010 HURLEY WAY, SUITE 101			SACRAMENTO, CA 95823
STRUCTURAL ENGINEERS ASSN.	ATTN: FRED CHEESEBROUGH	3631 MEADOW LANE		SACRAMENTO, CA 95825
DEPARTMENT OF PROTECTION & ADVOCACY	RUTH ORDAS	100 HOWE AVE, SUITE 185N		SACRAMENTO, CA 95825
SACRAMENTO COUNTY ENVIRONMENTAL HEALTH	ANNE FREY	8475 JACKSON ROAD, SUITE 240		SACRAMENTO, CA 95825
CONTRACTORS STATE LICENSE BOARD	ATTN: EXAM SERVICES	P.O. BOX 26000		SACRAMENTO, CA 95826
SACRAMENTO CO ENVIORNMENTAL HEALTH	MEL KNIGHT	DIRECTOR	8475 JACKSON RD., STE. 240	SACRAMENTO, CA 95826
ABESCO, INC.	ROGER COX	PRESIDENT	5851 FLORIN-PERKINS RD.	SACRAMENTO, CA 95826
CA. ASSN. OF HOMES FOR AGING	ATTN. DERRELL KELCH, DIRECTOR	7311 GREENHAVEN DR., SUITE 175		SACRAMENTO, CA 95828
CA. ASSN HOMES FOR THE AGING	DEAN R. SHETLER, EXEC. V.P.	7311 GREENHAVEN DR. #175		SACRAMENTO, CA 95831
VILLAGE GREEN MOBILEHOME PARK	BOB TROUTMAN	55 VILLAGE GREEN DRIVE		SACRAMENTO, CA 95831
WESTERN LIQUID GAS ASSOCIATION	P.O. BOX 60694			SACRAMENTO, CA 95838
YUBA COUNTY HOUSING AUTHORITY	938 14TH STREET			SACRAMENTO, CA 95860
CITY OF MARYSVILLE	P.O. BOX 150	1576 'B' N. BEALE RD.		MARYSVILLE, CA 95901
ROY TATE	P.O. BOX 5057	P.O. BOX 5057		MARYSVILLE, CA 95901
CASTLE MOBILE HOME	ROBERT	BUILDING OFFICIAL		MARYSVILLE, CA 95901
SERVICE UNLIMITED	ROY TATE	BUILDING OFFICIAL		MARYSVILLE, CA 95901
CITY OF MARYSVILLE	DAVE FRANCIS		P.O. BOX 150, 525 C STREET	MARYSVILLE, CA 95901
COUNTY OF YUBA	MARTIN GRIFFIN	1126 W. 17TH STREET	938 14TH STREET	MARYSVILLE, CA 95901-0150
JOAN T HAYNER	3130 ESPLANADE	3130 ESPLANADE		MARYSVILLE, CA 95901-4196
PLUMBERS & PIPE FITTERS LOCAL #607	ATTN: JIMMY THOMPSON	BUILDING OFFICIAL		CHICO, CA 95926
THE MOBILEHOME CENTER	JOAN HAYNER	BUILDING OFFICIAL	P.O. BOX 3420	CHICO, CA 95926
CITY OF CHICO	ANTOINE BAPTISTE	BUILDING OFFICIAL	425 WEBSTER STREET	CHICO, CA 95926
CITY OF COLUSA	HYRUM B FEDJE	P.O. BOX 530	220 12TH STREET	CHICO, CA 95927
COUNTY OF COLUSA	TOM CROSS	BUILDING OFFICIAL		COLUSA, CA 95932
JERRY FAULKNER/MARK FLATTER	JERRY FAULKNER	BOX 1025	P.O. BOX 530	COLUSA, CA 95932
COUNTY OF SIERRA	TIM H BEALS	BUILDING OFFICIAL		DOWNIEVILLE, CA 95936
GRASS VALLEY UNION	ATTN: JUDY MOOERS		CITY HALL, 125 EAST MAIN STREET	DOWNIEVILLE, CA 95936
CITY OF GRASS VALLEY	TERRY L KNOX	BUILDING OFFICIAL		GRASS VALLEY, CA 95945
MICHAEL SCHWALM	14162 LAKE WILDWOOD DR.	9955 LIVE OAK BOULEVARD	685 KENTUCKY STREET	GRASS VALLEY, CA 95945
CITY OF GRIDLEY	J.L. GLANDER	950 MAIDU AVE.		PENN VALLEY, CA 95946
CITY OF LIVE OAK	BILL CRENSHAW	950 MAIDU AVE.		GRIDLEY, CA 95948
COUNTY OF NEVADA	ATTN: CLINT MCKINLEY	BUILDING OFFICIAL	950 MAIDU AVENUE	LIVE OAK, CA 95953
NEVADA COUNTY	CLINT MCKINLEY			NEVADA CITY, CA 95959
COUNTY OF NEVADA	CLINT MCKINLEY			NEVADA CITY, CA 95959
SUPERHOUSE	P.O. BOX 731			NEVADA CITY, CA 95959
				NEVADA CITY, CA 95959

CITY OF NEVADA CITY	PENNY HORTON	BUILDING OFFICIAL	P.O. BOX 6100	NEVADA CITY, CA 95959
CITY OF OROVILLE	DAVID NOEL	BUILDING OFFICIAL	1735 MONTGOMERY STREET	OROVILLE, CA 95965
CITY OF BIGGS	MICHAEL VIERRA	BUILDING OFFICIAL	7 COUNTY CENTER DRIVE	OROVILLE, CA 95965
COUNTY OF BUTTE	MICHAEL VIERRA	BUILDING OFFICIAL	7 COUNTY CENTER DRIVE	OROVILLE, CA 95965
GDA ENGINEERING & SURVEYING	ATTN: KENNETH LENHARDT, P.E.	220 GRAND AVENUE		OROVILLE, CA 95966
CITY OF WILLOWS	MALLORY BRADLEY	BUILDING OFFICIAL	445 S. BUTTE ST.	WILLOWS, CA 95968
CITY OF PARADISE	TOM LEONARD	BUILDING OFFICIAL	5555 SKYWAY	PARADISE, CA 95969
COUNTY OF PLUMAS	DON SIMAS	BUILDING OFFICIAL	520 MAIN STREET, ROOM 115	QUINCY, CA 95971
PLUMAS COUNTY BUILDING DEPARTMENT	RANDY HICKS	P.O. BOX 10179		QUINCY, CA 95971-6009
CITY OF GLENN	BRADLEY H MALLORY	BUILDING OFFICIAL	445 SOUTH BUTTE STREET	GLENN, CA 95988
COUNTY OF GLENN	DAN L GARDNER	BUILDING OFFICIAL	125 SOUTH MURDOCK	WILLOWS, CA 95988
PLUMBERS & PIPE FITTERS LOCAL #228	ATTN: WM. DOUTHAT	723 SUTTER ST.		YUBA CITY, CA 95991
CITY OF LIVE OAK	DANNIE MC VEY	BUILDING OFFICIAL	1077 CIVIC CENTER BOULEVARD	YUBA CITY, CA 95991
FAR WEST HOMES, INC.	P. O. BOX 1238			YUBA CITY, CA 95992
CAST IRON SOIL PIPE INSTITUTE	IRA W. SCHUMER	1521 COATS DRIVE		YUBA CITY, CA 95993
CITY OF YUBA	ROBERT STODDARD	BUILDING OFFICIAL	1201 CIVIC CENTER BOULEVARD	YUBA, CA 95993
COUNTY OF SUTTER	TED SCHOPPE	BUILDING OFFICIAL	1160 CIVIC CENTER BLVD., SUITE E	YUBA CITY, CA 95993
PLUMBERS & PIPE FITTERS LOCAL #662	ATTN: BEN ANDERSON	904 LOCUST ST., ROM 5		REDDING, CA 96001
CITY OF REDDING, BUILDING DIVISION	GUY ERICKSON	760 PARKVIEW AVE.	1855 PLACER STREET	REDDING, CA 96001
COUNTY BLDG OFFICIAL ASSN. OF	HARVEY HOLQUIST	CALIFORNIA	1855 PLACER STREET	REDDING, CA 96001
COUNTY BUILDING OFFICIALS ASSN	HARVEY L HOLMQUIST	OF CALIFORNIA	1855 PLACER STREET, SUITE 102	REDDING, CA 96001
COUNTY OF SHASTA	RALPH OVERBAY	BUILDING OFFICIAL	760 PARKVIEW AVENUE	REDDING, CA 96001
CITY OF REDDING	TED M VOGES	BUILDING OFFICIAL	777 CYPRESS AVE.	REDDING, CA 96001
CITY OF REDDING	DAVID GERARD	HOUSING DIVISION		REDDING, CA 96001-3396
AL KRUMVIEDA	20250 B SKYPARK DRIVE		1887 HOWARD STREET	REDDING, CA 96002
CITY OF ANDERSON	MICHAEL R KNIGHT	BUILDING OFFICIAL		ANDERSON, CA 96007
RON'S MOBILE HOME SERVICE	RON ROBBINGS	P.O. BOX 305	794 3RD STREET	ANDERSON, CA 96007
CITY OF CORNING	JACK ALEXANDER	BUILDING OFFICIAL	CITY HALL, P.O. BOX 528	CORNING, CA 96021
CITY OF DORRIS	JACK FLEMING	BUILDING OFFICIAL	5915 DUNSMUIR AVE.	DORRIS, CA 96023
CITY OF DUNSMUIR	JIM ARATA	BUILDING OFFICIAL	P.O. BOX 460	DUNSMUIR, CA 96025
CITY OF ETNA	BOB FIOCK	BUILDING OFFICIAL		ETNA, CA 96027
CITY OF FORT JONES	BUILDING OFFICIAL	P.O. BOX 40		FORT JONES, CA 96032
SIERRA PACIFIC MOBILE HOME SERVICES INC.	ATTN: BO OHE	P O. BOX 494999		REDDING, CA 96049
SIERRA PACIFIC MOBILE HOME SERVICES INC.	BO OHE	P.O. BOX 494999		REDDING, CA 96049
PAT MURPHY	8255 HWY 99E			LOS MOLINAS, CA 96055
CITY OF MOUNT SHASTA	CHUCK TURK	BUILDING OFFICIAL	305 NORTH MT. SHASTA BOULEVARD	MOUNT SHASTA, CA 96067
COUNTY OF TEHEMA	BRUCE GUNN	BUILDING OFFICIAL	P.O. BOX 458	RED BLUFF, CA 96080
CITY OF TEHEMA	BUILDING OFFICIAL	P.O. BOX 458		RED BLUFF, CA 96080
CITY OF RED BLUFF	CHARLES E HAYDEN	BUILDING OFFICIAL	PO BOX 400, 555 WASHINGTON STREET	RED BLUFF, CA 96080
COUNTY OF TEHAMA	KATHY THOMAS	BUILDING OFFICIAL	P.O. BOX 458	RED BLUFF, CA 96080
MURRAY'S BUILDING & REPAIR	GREG MURRAY	P.O. BOX 616		SEIAD VALLEY, CA 96086
TRINITY COUNTY	BILL BRADFORD	BUILDING OFFICIAL	P.O BOX 476	WEAVERVILLE, CA 96093
COUNTY OF TRINITY	BILL BRADFORD	BUILDING OFFICIAL	P.O. BOX 476	WEAVERVILLE, CA 96093
CITY OF WEED	CRAIG SHARP	BUILDING OFFICIAL	PO BOX 470	WEED, CA 96094-0470
CITY OF MONTAGUE	BOB FIOCK	BUILDING OFFICIAL	305 BUTTE SO. CO. COURTHOUSE ANNEX	YREKA, CA 96097
CITY OF YREKA	LEROY MANLEY	BUILDING OFFICIAL	CITY HALL 701 4TH STREET	YREKA, CA 96097
COUNTY OF SISKIYOU	ROBERT D FIOCK	BUILDING OFFICIAL	305 BUTTE STREET	YREKA, CA 96097
CITY OF ALTURAS	JOHNNY VOLLENDROFF	BUILDING OFFICIAL	200 NORTH STREET	ALTURAS, CA 96101
COUNTY OF ALTURAS	RICK HIRONYMOUS	BUILDING OFFICIAL	202 W. 4TH STREET	ALTURAS, CA 96101
BUILDING INSPECTOR	RICK HIRONYMOUS	BUILDING INSPECTOR	202 W. 4TH STREET	ALTURAS, CA 96101
COUNTY OF MODOC	THOMAS TRACY	DEPARTMENT OF PUBLIC WORKS	202 W. FOURTH ST.	ALTURAS, CA 96101
CITY OF ALTURAS	TOM S TRACY	BUILDING OFFICIAL	202 WEST FOURTH STREET	ALTURAS, CA 96101
CITY OF LOYALTON	TIM H BEALS	BUILDING OFFICIAL	115 FRONT STREET	LOYALTON, CA 96118
ALPINE CO. PLANNING DEPT.	17300 HWY. 89	BUILDING OFFICIAL		MARKLEVILLE, CA 96120
COUNTY OF ALPINE	RANDY GIBSON	BUILDING OFFICIAL	17300 STATE ROUTE 89	MARKLEVILLE, CA 96120
CITY OF PORTOLA	VERLIN WOODS	66 N. LASSEN STREET	47 THIRD AVENUE, PO BOX 362	PORTOLA, CA 96122
ADMIN. SERVICES DIRECTOR	JAY W RICE	BUILDING OFFICIAL		SUSANVILLE, CA 96130
CITY OF SUSANVILLE	KEN CURTOLA	BUILDING OFFICIAL	66 NORTH LASSEN STREET	SUSANVILLE, CA 96130
COUNTY OF LASSEN	KEVIN BAILEY	BUILDING OFFICIAL	707 NEVADA ST., RM. 236	SUSANVILLE, CA 96130
CITY OF TULELAKE	FRANK TELLETT	BUILDING OFFICIAL	CITY HALL, P.O. BOX 847	TULELAKE, CA 96134
CITY OF SOUTH LAKE TAHOE	WILLIAM NILES	BUILDING OFFICIAL	1052 TATA LN	SOUTH LAKE TAHOE, CA 96150
GUERDON INDUSTRIES, INC.	5285 MEADOWS ROAD #315			LOAKE OSWEGO, OR 97035-3228
BORDEN CHEMICAL COMPANY	ATTN: JOHN M. HINE	610 SO. SECOND STREET		SPRINGFIELD, OR 97477
JOE R DALE	P. O. BOX 3187			CENTRAL POINT, OR 97502
JAMES BENNETT	502 MAAIKE DR	P.O. BOX 4109		MEDFORD, CA 97504
CEDAR HOMES, INC.	ATTN: DON W. NELSON, MGR.			BELLEVUE, WA 98009
AMERICAN PLYWOOD ASSOCIATION	P.O. BOX 11700	BUILDING OFFICIAL	CITY HALL, P.O. BOX 125	TACOMA, WA 98411
CITY OF WILLIAMS	TIM CROSS	IMPERIAL COUNTY	939 MAIN STREET	WILLIAMS, CA 98987
BUILIDNG INSPECTOR & MHP CO-ORDINATOR	MARCUS S TAPIA			EL CENTRO, CA 99243

ALTURAS PUBLIC WORKS DEPARTMENT	200 NORTH STREET	ALTURAS, 96101
BLYTHE DEVELOPMENT SERVICES DEPARTMEN	607 EAST HOBSON WAY	BLYTHE, 92225
ADELANTO BUILDING DEPARTMENT	P.O. BOX 10	ADELANTO, CA 92301
ALAMEDA ENVIRONMENTAL HEALTH	1131 HARBOR BAY PKWY, RM 250	ALAMEDA, CA 94502-6577
MODOC BUILDING DEPARTMENT	202 WEST FOURTH STREET	ALTURAS, CA 96101
ANAHEIM BUILDING DIVISION	P.O. BOX 3222	ANAHEIM, CA 92803
PACESETTER INDUSTRIES INC	2507 HERITAGE DR	ATWATER, CA 95301
BELL BUILDING DEPARTMENT	6330 PINE AVENUE	BELL, CA 90201
BIG BEAR LAKE BUILDING DEPARTMENT	P.O. BOX 10000	BIG BEAR LAKE, CA 92315-8900
BRISBANE BUILDING DEPARTMENT	150 NORTH HILL DRIVE, SUITE 40	BRISBANE, CA 94005
BURBANK BUILDING DEPARTMENT	275 EAST OLIVE AVENUE	BURBANK, CA 91510
CALISTOGA BUILDING DEPARTMENT	1232 WASHINGTON STREET	CALISTOGA, CA 94515
CAMARILLO BUILDING DEPARTMENT	601 CARMEN DRIVE	CAMARILLO, CA 93010
CARLSBAD BUILDING DEPARTMENT	2075 LAS PALMAS DRIVE	CARLSBAD, CA 92009
CATHEDRAL CITY BUILDING DEPARTMENT	68-700 AVENIDA LALO GUERRERO	CATHEDRAL CITY, CA 92234
ECO BUILDING SYSTEMS, INC.	596 SANDPIPER WAY, BLDG 910	CHULA VISTA, CA 91910
ECO BUILDING SYSTEMS	596 SANDPIPER WAY BLDG 1	CHULA VISTA, CA 91910
CHULA VISTA BUILDING DEPARTMENT	276 FOURTH AVENUE	CHULA VISTA, CA 91910
CITY OF CLEARLAKE	1450 OLYMPIC	CLEARLAKE, CA 95422
COACHELLA BUILDING DEPARTMENT	1515 SIXTH STREET	COACHELLA, CA 92236
COLFAX BUILDING DEPARTMENT	P.O. BOX 702	COLFAX, CA 95713
COMPTON BUILDING DEPT	205 SO. WILLOWBROOK	COMPTON, CA 90220
DELAWARE WESTERN HOMES CORP	299 N SMITH AVE	CORONA, CA 91720
DEL NORTE BUILDING DEPARTMENT	981 H STREET	CRESCENT CITY, CA 95531
CUDAHY BUILDING DEPARTMENT	5220 SANTA ANA STREET	CUDAHY, CA 90201
CYPRESS BUILDING DEPARTMENT	5275 ORANGE AVENUE	CYPRESS, CA 90630
DANA POINT COMMUNITY DEVELOPMENT DEPT.	33282 GOLDEN LANTERN	DANA POINT, CA 92629
DESERT HOT SPRINGS BUILDING DEPARTMENT	65950 PIERSON BOULEVARD	DESERT HOT SPRINGS, CA 92240
DINUBA BUILDING DEPARTMENT	405 EAST EL MONTE WAY	DINUBA, CA 93618
EL CAJON BUILDING DEPARTMENT	200 EAST MAIN, THIRD FLOOR	EL CAJON, CA 92020
IMPERIAL BUILDING DEPARTMENT	939 MAIN STREET	EL CENTRO, CA 92243
EL MONTE BUILDING DEPARTMENT	11333 EAST VALLEY BOULEVARD	EL MONTE, CA 91731
ESCONDIDO BUILDING DEPARTMENT	201 NORTH BROADWAY	ESCONDIDO, CA 92025
FOLSOM BUILDING DEPARTMENT	300 PERSIFER STREET	FOLSOM, CA 95630
FONTANA BUILDING DEPARTMENT	8353 SIERRA AVENUE	FONTANA, CA 92335
FOUNTAIN VALLEY BUILDING DEPARTMENT	P.O. BOX 8030	FOUNTAIN VALLEY, CA 92728-8030
GREENFIELD BUILDING DEPARTMENT	P.O. BOX 127	GREENFIELD, CA 93927
HEMET BUILDING & SAFETY	450 EAST LATHAM AVENUE	HEMET, CA 92543
INDIO BUILDING DEPARTMENT	P.O. DRAWER 1788	INDIO, CA 92202
IRVINE INSPECTION DIVISION	P.O. BOX 19575	IRVINE, CA 92713
LA MESA BUILDING DEPARTMENT	8130 ALLISON AVENUE	LA MESA, CA 91941
LAKE ELSINORE BUILDING & SAFETY DEPARTME	130 SOUTH MAIN	LAKE ELSINORE, CA 92530
RESOURCES, APPLICATIONS, DESIGNS AND CON	3220 EAST 59TH STREET	LONG BEACH, CA 90805
LOS ALAMITOS BUILDING DEPARTMENT	P.O. BOX 3147	LOS ALAMITOS, CA 90720-0347
P.F.S. CORPORATION	3637 MOTOR AVE	STI LOS ANGELES, CA 90034
LYNWOOD BUILDING DEPARTMENT	11330 BULLIS ROAD	LYNWOOD, CA 90262
MARINA BUILDING OFFICIAL	211 HILLCREST AVENUE	MARINA, CA 93933
CONTRA COSTA BUILDING DEPARTMENT	651 PINE ST., 4TH FL. MAIN BLDG.	MARTINEZ, CA 94553
FRIENDLY VILLAGE	120 DIXON LANDING RD	MILPITAS, CA 95035
MOBILELODGE OF MILPITAS	1515 N MILPITAS	MILPITAS, CA 95035
JOHNSVILLE MHP	1504 S MAIN ST	MILPITAS, CA 95035
PIONEER MHP	60 WILSON WAY	MILPITAS, CA 95035
MODESTO BUILDING DEPARTMENT	P.O. BOX 642	MODESTO, CA 95353
STANISLAUS DEPT. OF ENVIRONMENTAL HEALTH	3800 CORNUCOPIA WAY, SUITE C	MODESTO, CA 95358-9492

NAPA ENVIRONMENTAL HEALTH	1195 THIRD STREET, ROOM 205	NAPA, CA 94559
NEEDLES BUILDING DEPARTMENT	817 THIRD STREET	NEEDLES, CA 92363
NORWALK BUILDING DEPARTMENT	12700 SOUTH NORWALK BOULEVARD, RM 3	NORWALK, CA 90650
INSPECTION CONCEPTS	14108 ORANGE AVE	PARAMOUNT, CA 90723
PATTERSON BUILDING DEPARTMENT	P.O. BOX 667	PATTERSON, CA 95363
PITTSBURG BUILDING DEPARTMENT	P.O. BOX 1518	PITTSBURG, CA 94565
PLACENTIA BUILDING DEPARTMENT	401 EAST CHAPMAN	PLACENTIA, CA 92670
PORT HUENEME BUILDING DEPARTMENT	250 NORTH VENTURA BOULEVARD	PORT HUENEME, CA 93041
C.I. PROFESSIONAL SERVICES	3362 MONIER CIRCLE, #2	RANCHO CORDOVA, CA 95742
REDLANDS BUILDING DEPARTMENT	P.O. BOX 3005	REDLANDS, CA 92373
REDONDO BEACH BUILDING DEPARTMENT	P.O. BOX 270	REDONDO BEACH, CA 90277
SAN MATEO COUNTY	590 HAMILTON STREET	REDWOOD CITY, CA 94063
RIALTO BUILDING DEPARTMENT	150 S. PALM AVE.	RIALTO, CA 92376
RIVERSIDE ENVIRONMENTAL SERVICES	P.O. BOX 1206	RIVERSIDE, CA 92502
RIVERSIDE BUILDING DEPARTMENT	3900 MAIN STREET	RIVERSIDE, CA 92522
C.M.J. ENGINEERING, INC	4020 EL CAMINO AVE, STE D-4	SACRAMENTO, CA 95821
MONTEREY BUILDING DEPARTMENT	P.O. BOX 1208	SALINAS, CA 93902
SAN BERNARDINO COUNTY ENVIROMENTAL HEALT	385 N ARROWHEAD	SAN BERNARDINO, CA 92415
SAN BERNARDINO ENVIRONMENTAL HEALTH	385 N. ARROWHEAD	SAN BERNARDINO, CA 92415-0160
SAN BERNARDINO BUILDING AND PLANNING DEP	300 NORTH D STREET	SAN BERNARDINO, CA 92418
SAN CLEMENTE BUILDING DEPARTMENT	910 CALLE NEGOCIO, SUITE 100	SAN CLEMENTE, CA 92672
THE CITY OF SAN DIEGO	NEIGHBORHOOD CODE COMPLIANCE	120 SAN DIEGO, CA 92101
COUNTY OF SAN DIEGO	5201 RUFFIN ROAD, SUITE 'C'	520 SAN DIEGO, CA 92123-1666
CITY OF SAN DIMAS	245 EAST BONITA AVENUE	SAN DIMAS, CA 91773
SAN FRANCISCO DEPT. OF BUILD. INSPECTION	1660 MISSION STREET, SIXTH FLOOR	SAN FRANCISCO, CA 94103-2414
SAN JACINTO BUILDING DEPARTMENT	P.O. BOX 488	SAN JACINTO, CA 92581
CITY OF SAN JUAN CAPISTRANO	32400 PASEO ADELANTO	SAN JUAN CAPISTRANO, CA 92675
SAN MARCOS BUILDING DEPARTMENT	1 CIVIC CENTER DRIVE	SAN MARCOS, CA 92069-2949
CITY OF SANTA BARBARA	630 GARDEN	SANTA BARBARA, CA 93101
COUNTY OF SANTA BARABARA	123 EAST ANAPAMU STREET	SANTA BARBARA, CA 93101-2058
SANTA CLARA BUILDING DEPARTMENT	1500 WARBURTON AVENUE	SANTA CLARA, CA 95050
SANTA MARIA BUILDING DEPARTMENT	110 S. PINE, #101	SANTA MARIA, CA 93454-5082
SANTA MONICA BUILDING DEPARTMENT	1685 MAIN STREET	SANTA MONICA, CA 90401
SEAL BEACH BUILDING DEPARTMENT	211 EIGHTH STREET	SEAL BEACH, CA 90740
TUOLUMNE BUILDING DEPARTMENT	#2 GREEN STREET, 4TH FL, ANF. BLDG.	SONORA, CA 95370
SOUTH GATE BUILDING INSPECTION	8650 CALIFORNIA AVENUE	SOUTH GATE, CA 90280
TAFT BUILDING DEPARTMENT	209 EAST KERN STREET	TAFT, CA 93268
UNION CITY COMMUNITY DEVELOPMENT DEPT.	34009 ALVARADO-NILES ROAD	UNION CITY, CA 94587
CITY OF SAN BUENAVENTURA	501 POLI STREET	VENTURA, CA 93002
VENTURA DEPT. OF BUILDING & SAFETY	P.O. BOX 99	VENTURA, CA 93002
VICTORVILLE BUILDING DEPARTMENT	14343 CIVIC DRIVE	VICTORVILLE, CA 92392
VISTA BUILDING DEPARTMENT	P.O. BOX 1988	VISTA, CA 92083
WATERFORD BUILDING DEPARTMENT	P.O. BOX 199	WATERFORD, CA 95386
YORBA LINDA BUILDING DEPARTMENT	4845 CASA LOMA AVENUE	YORBA LINDA, CA 92686
CRESCENT CITY DEPT. OF PUBLIC WORKS	377 'J' STREET	CRESCENT CITY, 95531
DALY CITY ECONOMIC & COMMUNITY DEVELOPME	333 90TH STREET	DALY CITY, 94015-1895
HILBORN, WERNER, CARTER & ASSOCIATES, IN	1627 SOUTH MYRTLE AVE	CLEARWATER, FL 34616
T.R. ARNOLD & ASSOCIATES, INC	700 EAST BEARDSLEY AVE. STE 2-A	PO ELKHART, IN 46514
IONE CITY OF IONE BUILDING DEPT.	P.O. BOX 398	IONE, 95640
OCEANSIDE BUILDING DEPARTMENT	300 N. HILL STREET	OCEANSIDE, 92054
RANCHO MIRAGE BUILDING DEPARTMENT	69-825 HWY 111	RANCHO MIRAGE, 92270
SEBASTOPOL BUILDING DEPARTMENT	7425 BODEGA AVENUE	SEBASTOPOL, 95472
ST. HELENA ST. HELENA BUILDING DEPARTMEN	1480 MAIN STREET	ST. HELENA, 94574
WESTERN HOMES CORP. SILVERCREST	2550 WALNUT HILL LN #200	DALLAS, TX 75229

BFGoodrich
Specialty Chemicals

BFGoodrich Specialty Chemicals
9911 Brecksville Road
Cleveland, Ohio 44141-3247
216-447-5777
FAX 216-447-5730

Wayne O. Smith
President & Chief Operating Offic

September 1, 1995

The Honorable Pete Wilson
Governor of the State of California
State Capitol
Sacramento, CA 95814

Dear Governor:

I was delighted to have the opportunity to meet you in Columbus on August 26 to hear first hand your views on key issues. Your more "practical" platform should have broad appeal to the moderate majority. I was particularly taken by your adamant stance on the need for regulatory reform. On this note, you may recall, I offered an example of a regulatory barrier in California that has closed a market for one of our products that would have great benefit to your citizens.

I thought you might want to know a few more details of the issue. In many areas of your state, corrosion of copper pipe used in plumbing of residences is particularly troublesome because of the inherent characteristics of the water supply. We have developed specialty resins and compounds for the manufacture of a unique plastic pipe (CPVC) that is anti-corrosive and can be used in hot and cold water plumbing. This material is approved by all the major regional and national code organizations and used in all other states of the Union. In California it is used only for fire sprinkler systems and industrial piping systems. We would like to see the California market opened up to CPVC and the California consumer given a free choice of materials. But due to a long and drawn-out battle with the pipe trade unions and state regulatory policies developed in a previous democratic administration, CPVC pipe for plumbing is not allowed in California. Attached is a chronology of events going back to 1979 and some newspaper clippings that provide testimonial to the problem in California.

At this point, it is our understanding that the California Department of Housing can issue an approval of CPVC plumbing by edict. We would appreciate it if you would look into this regulatory block of a product that is used widely throughout the world and whose absence in California is causing significant harm to your constituents. Thank you for your interest. We would be pleased to provide further information or work with your designee.

Best wishes on your campaign. As I mentioned, your endorsement by Admiral Stockdale, my former senior ranking officer in "Hanoi" should be helpful.

Sincerely,

Wayne O. Smith

Wayne O. Smith

0828951.jas

GOVERNOR'S OFFICE

October 12, 1995

To the Members of the California Assembly:

On this date I have signed Assembly Bill No. 151.

This bill permits the limited use of chlorinated polyvinyl chloride (CPVC) piping within buildings, providing such use is permitted by a local jurisdiction prior to January 1, 1996.

This legislation affirms that issues involving the health and safety of construction standards and new building products should not be subject to environmental review. This bill takes into account not only numerous studies as to the safety of using plastic pipe for transporting potable water in residential dwellings, it acknowledges that the product is now being used in all other states in the nation.

While this legislation affects limited jurisdictions in the state, I am directing the Department of Housing and Community Development to propose adoption of emergency building standards and related regulations allowing the use of CPVC water piping within residential dwellings statewide.

Cordially,

Pete Wilson

PETE WILSON

7

GOVERNOR PETE WILSON · STATE CAPITOL · SACRAMENTO, CALIFORNIA 95814

State of California
BSC-1 (Rev. 11/23/87)

FACE SHEET

For Filing Building Standards and Notices of Hearings
With the Secretary of State
(Pursuant to Health and Safety Code Sections 18901-18949)

NOV 13

Copy below is hereby certified to be a true and correct copy of building standards to be noticed, adopted, amended, or repealed by:
DEPT OF HOUSING AND COMMUNITY DEVELOPMENT
(Agency)
Date of adoption, amendment, or repeal:
10/26/95
By: [signature]
DIRECTOR
(Title)

DO NOT WRITE IN THIS SPACE

DO NOT WRITE IN THIS SPACE

The attached building standards which are being noticed, adopted, amended, or repealed, are contained in Title 24 of the California Administrative Code. The Division, Part, Chapter, etc., affected by this order: Part 5 (UPC)

TYPE OF ORDER (Check as applicable):

__ Public Notice
__ Regular
__ Notice of General Public Interest
X Emergency
__ Editorial/Procedural Change
__ Resubmittal of previously submitted building standards
__ Certificate of Compliance/Noncompliance

SUBMITTAL REQUIREMENTS
Public Notice (6 copies)

One complete copy of the rulemaking file, as defined in CAC, Title 24, Sections 1-401 and 1-402. (3-hole punched)

In addition:
One signed copy of the Face Sheet (3-hole punched)

35 copies of the proposed Building Standards (3-hole punched)

35 copies of the Final Statement of Reasons (3-hole punched)

35 copies of the Nine Point Criteria Analysis (3-hole punched)

35 copies of the Finding of Emergency (for emergency adoptions only) (3-hole punched)

Request effective date of UPON FILING WITH THE SECRETARY OF STATE as specified by Statute _____.

RULEMAKING FILE

FINDING OF EMERGENCY

EMERGENCY AMENDMENT OF SECTION 604.1
OF THE 1994 UNIFORM PLUMBING CODE
(AS AMENDED BY HCD)

I. AUTHORITY AND REFERENCE

Authority for this regulation is provided by Sections 17921 and 17922 of the Health and Safety Code, and Section 11346.1 of the Government Code.

This regulation implements, interprets, and makes specific Sections 17921 and 17922 of the Health and Safety Code.

The Health and Safety Code requires the Department to adopt, amend, and repeal regulations establishing building standards for all hotels, motels, lodging houses, apartment houses and dwellings, and buildings and structures accessory thereto. Additionally, the Health and Safety Code provides that the enforcement agency for these regulations is the building department of the city, county, or city and county.

The Department proposes to amend Section 604.1 of the 1994 Edition of the Uniform Plumbing Code (as amended by the Department) of the California Code of Regulations, Title 24, Part 5.

II. LOCAL MANDATE

The proposed regulatory activity will not impose additional expenditures on local agencies.

III. STATEMENT OF COSTS

A. To state agencies: No cost.

B. To local agencies or school districts: No cost.

C. To federal financing to the state: No impact.

D. To housing costs:

The proposed emergency regulations will result in a savings to housing costs within California, as chlorinated polyvinyl chloride (CPVC) plastic pipe is more economical than metallic pipe for use within buildings.

RULEMAKING FILE
NO. 2

E. To small businesses:

The proposed emergency regulations will result in a savings to small businesses within California, as CPVC plastic pipe is more economical than metallic pipe for use within buildings.

F. To private persons or businesses:

The proposed emergency regulations will result in a savings to private persons and business within California, as CPVC plastic pipe is more economical than metallic pipe for use within buildings.

IV. INFORMATIVE DIGEST

A. HISTORICAL BACKGROUND

The uniform model codes are published once every three years for incorporation by reference into Title 24, California Code of Regulations (CCR), except for the UHC, which is adopted by reference into Title 25, CCR. The 1994 Uniform Plumbing Code (UPC) was proposed for adoption by reference into Title 24 CCR by the Department and approved by the California Building Standards Commission, effective July 1, 1995 for state enforcement.

In proposing adoption of the 1994 edition of the UPC, approved by the California Building Standards Commission, Section 604.1 was amended to exclude the use of CPVC plastic pipe within buildings.

The rationale for restricting the use of CPVC plastic pipe was the delayed completion of an Environmental Impact Report (EIR) examining the possible dangers associated with the use of CPVC plastic pipe for potable water piping within buildings. The Department has been conducting the study for 18 years to determine if the transportation of potable water in CPVC plastic pipe poses a health hazard. Although the contractor completing the initial environmental impact report submitted his findings to the Department, it was determined by the Department's Legal Affairs Office that additional information is required to comply with the California Environmental Quality Act (CEQA).

Although the EIR is yet to be fully completed, the initial findings of the EIR, coupled with the rise of current urgent circumstances, require the Department to repeal the state prohibition on the use of CPVC plastic pipe within buildings.

RULEMAKING FILE
2

The use of CPVC plastic pipe within manufactured home potable water systems is approved through construction standards developed pursuant to the National Manufactured Housing Construction and Safety Standards Act of 1974. The National Manufactured Housing Construction and Safety Standards Act is Federal Law and preempts state regulations with regards to manufactured homes. Therefore, state plumbing standards employed in construction of buildings are not applicable to manufactured homes.

California is the only state prohibiting the use of CPVC plastic pipe within buildings.

B. CURRENT SITUATION

Currently, various cities in California, such as the City of Colton, are experiencing serious difficulties with the use of metallic piping materials. Metallic piping materials react negatively to soil conditions within certain areas of California, causing excessive premature corrosion of the pipe and resulting in property damage, financial ruin, and severe hardship to homeowners, construction contractors, and insurance companies alike. The use of CPVC pipe will reduce health and safety hazards, and reduce the number of bankruptcies within the construction industry due to lawsuits over property damage caused by broken metallic water pipes.

Plastic piping materials, such as CPVC plastic piping, have been proven to maintain longer than metallic piping materials, and do not corrode as easily.

The Governor's October 12, 1995 signing message to the California Assembly regarding Chapter 785 contained provisions directing the Department of Housing to adopt emergency building standards permitting the use of CPVC water pipe within residential dwellings statewide.

In response to the urgent need to permit alternative piping materials to be used within buildings, the Department proposes these emergency regulations to permit the use of CPVC plastic pipe within buildings.

C. EFFECT OF PROPOSED ACTION

The proposed action will permit the use of CPVC plastic pipe for potable water piping within buildings.

V. DEMONSTRATION OF THE NEED FOR IMMEDIATE ACTION

Delayed implementation of this regulation will result in a severe adverse impact on the public. Corrosion of existing

RULEMAKING FILE
NO. 2

metallic piping systems within buildings is resulting in property damage, financial ruin, and severe hardship to homeowners, construction contractors, and insurance companies alike. Corrosion of metallic piping systems has caused the pipes to burst, flooding homes and resulting in lawsuits against construction contractors and claims against insurance companies. The lawsuits and construction contractors are bankrupting the contractors, and the claims against insurance policies are imposing a financial hardship upon the insurance companies.

The use of non-metallic piping systems within buildings such as CPVC plastic pipe will avoid the excessive premature corrosion currently experienced by residents of California.

Approval of this emergency adoption will assist the public by maintaining existing health and safety requirements contained within the 1994 Edition of the UPC.

VI. ALTERNATIVES TO IMMEDIATE ACTION

A. Maintain the Status Quo

Result of maintaining the status quo - If the regulation is not amended to permit the use of CPVC plastic pipe within buildings, homeowners within California will continue to be subject to water damage due to broken water pipes. Construction contractors will continue to be subject to lawsuits as a result of the corroded metallic water piping, and insurance companies will continue to be subject to claims as a result of the damage.

Timothy L. Coyle
Director

10/26/95
Date

RULEMAKING FILE
2
7

THOMAS R. ADAMS (SB No. 047372)
ANN BROADWELL (SB No. 054394)
DANIEL L. CARDOZO (SB No. 111382)
ADAMS & BROADWELL
A Professional Corporation
651 Gateway Boulevard, Suite 900
South San Francisco, CA 94080
Telephone: 415/589-1660

Attorneys for Petitioners

SUPERIOR COURT OF CALIFORNIA

COUNTY OF SAN FRANCISCO

RICHARD CUFFE; GREG BAKER; RON MORGAN; SAM GILL; CALIFORNIA PIPE TRADES COUNCIL; CALIFORNIA FIREFIGHTERS ASSOCIATION; PLANNING AND CONSERVATION LEAGUE; SIERRA CLUB; CALIFORNIA LEGISLATIVE CONFERENCE OF THE PLUMBING, HEATING AND PIPING INDUSTRY; and MECHANICAL CONTRACTORS ASSOCIATION OF NORTHERN CALIFORNIA, Petitioners, vs. CALIFORNIA BUILDING STANDARDS COMMISSION and CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT, Respondents. B. F. GOODRICH COMPANY, INC., Real Party in Interest.	Case No. 977657 PEREMPTORY WRIT OF MANDATE [CCP §§ 1087, 1104] Date: Time: Dept: 8 Room: Judge William Cahill

TO: CALIFORNIA BUILDING STANDARDS COMMISSION and CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT, RESPONDENTS:

Judgement having been entered in this action ordering that a peremptory writ of mandate issue from this court, Respondents CALIFORNIA BUILDING STANDARDS COMMISSION and CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT are hereby commanded immediately after receipt of this writ:

1. To delete approval of CPVC pipe for interior water distribution systems from the California Plumbing Code; and

2. To take no further action to adopt regulations approving the use of CPVC pipe for interior water distribution systems unless the Commission and HCD have followed the CEQA process beginning with an initial study and ending with either the production of a final environmental impact report or a negative declaration. Nothing in this court's decision shall be interpreted as requiring Respondents to proceed with the readoption of regulations approving the use of CPVC pipe after compliance Order;

3. To provide official notice to all local building officials of the action deleting approval of CPVC pipe for interior water distribution systems by sending an information bulletin to each building official. The information bulletin shall be mailed by Respondents within thirty (30) days of the date of issuance of this Peremptory Writ of Mandate.

4. To make and file a return to this writ within thirty (30) days of the date action is taken to delete the regulation approving the use of CPVC pipe for interior distribution systems

or the date that the information bulletin described in paragraph 1(c) of the Judgment Granting Peremptory Writ of Mandate is sent, whichever is later, showing what you have done to comply with this Writ and shall include a copy of the information bulletin prepared pursuant to paragraph 3.

[Seal]

ALAN CARLSON

Clerk

By: _____
Deputy Clerk

LET THE FOREGOING WRIT ISSUE.

Dated: 3/13/97 1997

Honorable William Cahill
Judge of the Superior Court

ENDORSED
FILED
San Francisco County Superior Court

JAN 21 1997

ALAN CARLSON, Clerk
BY: GAIL HEERLESH
Deputy Clerk

CALIFORNIA SUPERIOR COURT

CITY AND COUNTY OF SAN FRANCISCO

DEPARTMENT NUMBER EIGHT

RICHARD CUFFE; GREG BAKER; RON MORGAN; SAM GILL; CALIFORNIA PIPE TRADES COUNCIL; CALIFORNIA FIREFIGHTERS ASSOCIATION; PLANNING AND CONSERVATION LEAGUE; SIERRA CLUB; CALIFORNIA LEGISLATIVE CONFERENCE OF THE PLUMBING HEATING AND PIPING INDUSTRY; and MECHANICAL CONTRACTORS ASSOCIATION OF NORTHERN CALIFORNIA, Petitioners, vs. CALIFORNIA BUILDING STANDARDS COMMISSION and CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT, Respondents.	NO. 977657 **ORDER GRANTING WRIT OF MANDATE**

This matter came before the court on October 10, 1996. The Honorable William Cahill, presiding, orders this matter submitted. After further consideration of all papers and arguments, the court orders as follows:

IT IS HEREBY ORDERED THAT petitioners' request for a Writ of Mandate is GRANTED for the following reasons:

Every year Respondents, California Building Standards Commission and the California Department of Housing and Community Development enact the California Plumbing Code ("CPC"). This process begins with review of the then existing national Uniform Plumbing Code ("UPC"). Respondents then decide to either adopt the UPC in its entirety as this state's CPC or adopt a modified form of the UPC for California.

Beginning in the early 1980s, Respondents chose to adopt a modified UPC by amending it in regards to CPVC pipe. Consistently during that time, the UPC specifically approved CPVC pipe for use in transporting potable water for residential housing units and every year respondents specifically deleted those sections for California. For 14 years respondents chose to prohibit CPVC pipe use in this state.

This changed in 1995, when Governor Pete Wilson issued a directive to respondents ordering the approval of CPVC pipe. Respondents immediately changed their policy and removed their restrictions on the pipe by adopting emergency regulations changing its policy. In March 1996, at its regular meeting, respondents simply chose not to delete the portion of the UPC which approved CPVC pipe for residential use. These acts permitted California builders of residential plumbing, for the first time in 14 years, to choose to use CPVC pipe for their projects.

This court finds that respondents' change of position in this area requires CEQA review before it goes into effect. Respondents argue that their actions in 1995 and 1996 were merely "ministerial" in that they merely adopted the UPC without change. This argument ignores the fact that the board was in fact exercising its discretion to change not only a 14-year old statewide construction policy, but also the substantive plumbing code. Making such a choice, by definition, is a discretionary act, and since CEQA applies to "discretionary projects proposed to be carried out or approved by public agencies . . . " (Pub.Res.Code Sec. 21080(a)), the respondents' actions in regards to CPVC pipe requires CEQA review under California law.

An exemption to CEQA occurs only "where it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment."

(Guidelines sec. 15061(b)(3)). The record presented to this court on CPVC's effect on the environment does not permit this court to find that there is no possibility that CPVC pipe would not affect the environment significantly. There is a dispute between the parties regarding the extent of the possibility of chemical leaching and solvents polluting drinking water carried in the pipe. In addition there is a dispute regarding potential chemical exposure to workers installing the pipe. Apparently there is some validity to petitioners' position because for 14 years respondents agreed with them.

Whether or not there should be a ban in California on CPVC pipe for residential use is not something which this or any court should be involved with. The decisions in this area are solely for the legislature and the executive branch, but these branches of government have passed and enacted into law the California Environmental Quality Act, and it is the duty of this court to insure that CEQA is complied with when required by law. This is one of those instances.

As such, the Respondent agencies were required to initiate the CEQA process, beginning with an initial study, and ending with either the production of a final Environmental Impact Report, or a Negative Declaration. Neither was produced in this case, rendering the process in violation of CEQA. Thus, petitioners' writ of mandate is GRANTED.

DATED: 1/21/97

William Cahill
San Francisco Superior Court

CALIFORNIA SUPERIOR COURT

CITY AND COUNTY OF SAN FRANCISCO

DEPARTMENT NUMBER EIGHT

RICHARD CUFFE; GREG BAKER; RON MORGAN; SAM GILL; CALIFORNIA PIPE TRADES COUNCIL; CALIFORNIA FIREFIGHTERS ASSOCIATION; PLANNING AND CONSERVATION LEAGUE; SIERRA , Petitioners, vs. CALIFORNIA BUILDING STANDARDS COMMISSION and CALIFORNIA DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT,, Respondents.	NO. 977657 **CERTIFICATE OF SERVICE BY MAIL (CCP 1013a(4))**

I, Gail Perlera, a deputy clerk of the Superior Court for the City and County of San Francisco, certify that:

1) I am not a party to this action;

2) On January 21, 1997, I served the attached:

ORDER GRANTING WRIT OF MANDATE

by placing a copy in a sealed envelope, addressed as follows:

ANN BROADWELL
DANIEL CARDOZO
ADAMS & BROADWELL
651 Gateway Blvd, Suite 900
South San Francisco, CA 94080

KEITH HOWARD
TONY HAWTHORNE
COOPER WHITE & COOPER
1333 N. California Blvd, Suite 450, Walnut Creek, CA 94596

M. ANNE JENNINGS
Deputy Attorney General
2101 Webster Street, 12th Floor
Oakland, CA 94612-3049

MICHAEL J. VAN ZANDT
MCQUAID, METZLER, McCORMICK & VAN ZANDT
One Maritime Plaza
Golden Gateway Center, 23rd Floor
San Francisco, CA 94111

and,

3) I then placed the sealed envelope in the outgoing mail at 633 Folsom Street, San Francisco, CA, 94107 on the date indicated above for collection, attachment of required prepaid postage, and mailing on that date following the standard court practices.

January 21, 1997

Gail Perlera
Deputy Clerk

INITIAL STUDY

For the proposed adoption of regulations (building standards) for the use of chlorinated polyvinyl chloride (CPVC) pipe, an optional alternative to metal pipe in potable water systems of residential buildings.

Lead Agency: The California Department of Housing and Community Development

August 1997

Prepared by:

Robin Reynolds
Environmental Program Manager
California Department of Housing and Community Development
1800 Third Street, Suite 440
Sacramento, California 95814
(916) 323-7288

Introduction

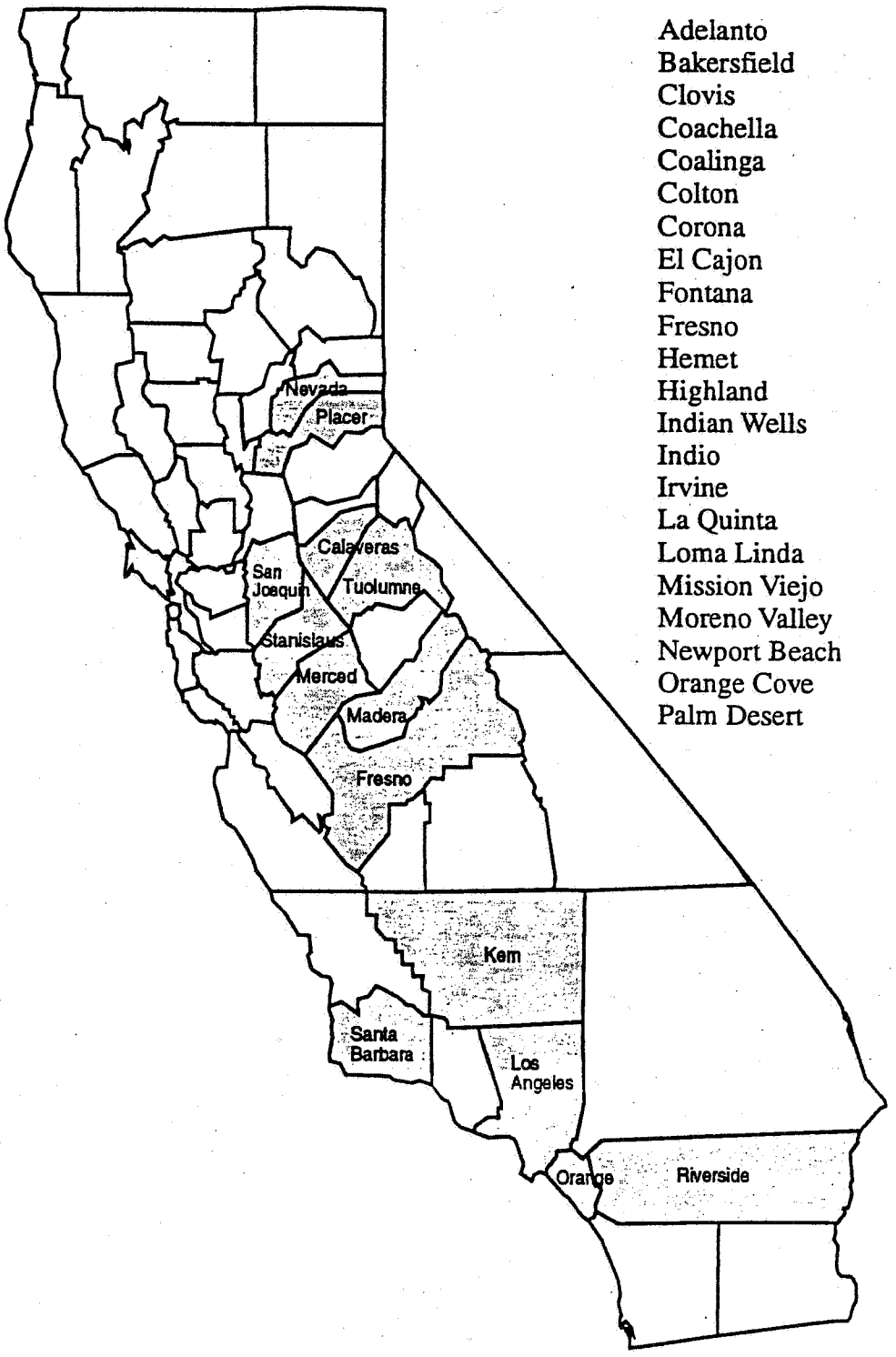
This Initial Study is for the proposed adoption of regulations (building standards) for the use of chlorinated polyvinyl chloride (CPVC) pipe, in addition to metal pipe in the potable water systems of residential buildings. The proposed regulations would apply to, and thus could effect residential building construction, rehabilitation, and repair in all areas of the State. Residential buildings include single-family dwellings, apartment houses, hotels and motels.

CPVC pipe is currently allowed and is used in California for potable water pipe in mobile homes, other manufactured homes, recreational vehicles, public drinking water treatment and distribution systems, and for general residential building uses in some local jurisdictions[i] (see map on following page for a summary). For the majority of existing residential buildings in California, the potable water pipe is made of metal. The permitted use of metal pipe in new or existing residential buildings would continue under the proposed regulations. In addition to the potential environmental effects identified in this Initial Study, there could also be economic and social effects associated with the adoption of the proposed regulations.

Compliance with the California Environmental Quality Act (CEQA) was required for the consideration of the proposed regulations by court order (*Richard Cuffe et al. vs. California Building Standards, et al.* San Francisco County Superior Court Case Number 977657.[ii]) The court based the decision that the fact that for the past 14 years the California Building Code had explicitly excluded CPVC pipe from the plumbing code for residential construction: A change in policy of this nature required CEQA compliance, the court held.

PROJECT LOCATION: The State of California

Counties where CPVC is permitted for use are highlighted in map. In addition, the following cities have notified the Lead Agency that they permit the use of CPVC.



Adelanto
Bakersfield
Clovis
Coachella
Coalinga
Colton
Corona
El Cajon
Fontana
Fresno
Hemet
Highland
Indian Wells
Indio
Irvine
La Quinta
Loma Linda
Mission Viejo
Moreno Valley
Newport Beach
Orange Cove
Palm Desert
Placentia
Porterville
Rialto
Riverbank
Sacramento
San Juan Capistrano
Santa Ana
Santa Clarita
Santa Maria
Seal Beach
Selma
Temecula
Tracy
Turlock
Tustin
Victorville
Visalia
Vista

Environmental Checklist Form

1. **Project Title:** Chlorinated Polyvinyl Chloride (CPVC) Pipe.

2. **Lead Agency Name and Address:** Department of Housing and Community Development
1800 Third Street
Sacramento, California 95814

3. **Contact Person and Phone Number:** Robin Reynolds (916) 323-7280

4. **Project Location:** Statewide

5. **Project Sponsor's Name and Address:** N/A. This project is a proposed action by a State Agency

6. **General Plan Designation:** N/A

7. **Zoning:** Generally residential.

8. **Description of Project:** (Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation. Attach additional sheets if necessary.)

The proposed adoption of regulations (building standards) for the use of CPVC pipe, as an optional alternative to metal pipe in the potable water systems of residential buildings.

9. **Surrounding Land Uses and Setting:** Briefly describe the project's surroundings.

This is a statewide project, and is not site-specific. However, in general, the surrounding uses of sites (residences) where CPVC might be used, if the project is approved, would be residential.

10. **Other agencies whose approval is required**
(e.g., permits, financing approval, or participation agreement.)

The California Building Standards Commission.

Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Land Use and Planning	☐ Transportation/Circulation	☐ Public Services
☐ Population and Housing	☐ Biological Resources	☒ Utilities and Service Systems
☐ Geological Problems	☒ Energy and Mineral Resources	☐ Aesthetics
☒ Water	☒ Hazards	☐ Cultural Resources
☒ Air Quality	☐ Noise	☐ Recreation
	☒ Mandatory Findings of Significance	

Determination.

(To be completed by the Lead Agency.)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared. ☐

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because the mitigation measures described on an attached sheet have been added to the project. A NEGATIVE DECLARATION will be prepared. ☐

I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required. ☒

I find that the proposed project MAY have a significant effect(s) on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets, if the effect is a "potentially significant impact" or "potentially significant unless mitigated." An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed. ☐

I find that although the proposed project could have a significant effect on the environment, there WILL NOT be a significant effect in this case because all potentially significant effects (a) have been analyzed adequately in an earlier EIR pursuant to applicable standards and (b) have been avoided or mitigated pursuant to that earlier EIR, including revisions or mitigation measures that are imposed upon the proposed project. ☐

Robin Reynolds
Signature

Aug 11, 1997
Date

Robin Reynolds
Printed Name

—
For

Evaluation of Environmental Impacts:

1) A brief explanation is required for all answers except "No Impact" answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A "No Impact" answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g. the project falls outside a fault rupture zone). A "No Impact" answer should be explained where it is based on project-specific factors as well as general standards (e.g. the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).
2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.
3) "Potentially Significant Impact" is appropriate if there is substantial evidence that an effect is significant. If there are one or more "Potentially Significant Impact" entries when the determination is made, an EIR is required.
4) "Potentially Significant Unless Mitigated Incorporated" applies where the incorporation of mitigation measures has reduced an effect from "Potentially Significant Impact" to a "Less than Significant Impact." The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, "Earlier Analyses," may be cross-referenced).
5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). Earlier analyses are discussed in Section XVII at the end of the checklist.
6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated. See the sample question below. A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.
7) This is only a suggested form, and lead agencies are free to use different ones.

Sample Question:

Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the proposal result in potential impacts involving:				
Landslides or mudslides? (1, 6) (Attached source list explains that 1 is the general plan, and 6 is a USGS topo map. This answer would probably not need further explanation.)	☐	☐	☐	☐
I. LAND USE AND PLANNING. Would the proposal:				
a) Conflict with general plan designation or zoning? (source #(s): (ix)	☐	☐	☐	☒
b) Conflict with applicable environmental plans or policies adopted by agencies with jurisdiction over the project? (ix)	☐	☐	☐	☒
c) Be incompatible with existing land use in the vicinity? (ix)	☐	☐	☐	☒

Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Unless Mitigation Incorporated	Less Than Significant Impact	Significant No Impact
d) Affect agricultural resources or operations (e.g., impacts to soils or farmlands, or impacts from incompatible land uses)? (ix)	☐	☐	☐	☒
e) Disrupt or divide the physical arrangement of an established community (including a low-income or minority community)? (ix)	☐	☐	☐	☒
II. POPULATION AND HOUSING. Would the proposal:				
a) Cumulatively exceed official regional or local population projections? (ix)	☐	☐	☐	☒
b) Induce substantial growth in an area either directly or indirectly (e.g. through projects in an undeveloped area or extension of major infrastructure)? (ix)	☐	☐	☐	☒
c) Displace existing housing, especially affordable housing? (ix)	☐	☐	☐	☒
III. GEOLOGIC PROBLEMS. Would the proposal result in or expose people to potential impacts involving:				
a) Fault rupture? (ix)	☐	☐	☐	☒
b) Seismic ground shaking? (ix)	☐	☐	☐	☒
c) Seismic ground failure, including liquefaction? (ix)	☐	☐	☐	☒
d) Seiche, tsunami, or volcanic hazard? (ix)	☐	☐	☐	☒
e) Landslides or mudflows? (ix)	☐	☐	☐	☒
f) Erosion, changes in topography or unstable soil conditions from excavation, grading, or fill? (ix)	☐	☐	☐	☒
g) Subsidence of the land? (ix)	☐	☐	☐	☒
h) Expansive soils? (ix)	☐	☐	☐	☒
i) Unique geologic or physical features? (ix)	☐	☐	☐	☒
IV. WATER. Would the proposal result in:				
a) Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff? (ix)	☐	☐	☐	☒
b) Exposure of people or property to water related hazards such as flooding? (ii , ix)	☒	☐	☐	☐
c) Discharge into surface waters or other alteration of surface water quality (e.g. temperature, dissolved oxygen or turbidity)? (iii , ix)	☒	☐	☐	☐
d) Changes in the amount of surface water in any water body? (ix)	☐	☐	☐	☒
e) Changes in currents, or the course or direction of water movements? (ix)	☐	☐	☐	☒

Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
f) Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations, or through substantial loss of groundwater recharge capability? (ix)	☐	☐	☐	☒
g) Altered direction or rate of flow of groundwater? (ix)	☐	☐	☐	☒
h) Impacts to groundwater quality? (ix)	☐	☐	☐	☒
i) Substantial reduction in the amount of groundwater otherwise available for public water supplies? (ix)	☐	☐	☐	☒
V. AIR QUALITY. Would the proposal:				
a) Violate any air quality standard or contribute to an existing or projected air quality violation? (iv, ix)	☒	☐	☐	☐
b) Expose sensitive receptors to pollutants? (ix)	☐	☐	☐	☒
c) Alter air movement, moisture, or temperature, or cause any change in climate? (ix)	☐	☐	☐	☒
d) Create objectionable odors? (ix)	☐	☐	☒	☐
VI. TRANSPORTATION/CIRCULATION. Would the proposal result in:				
a) Increased vehicle trips or traffic congestion? (ix)	☐	☐	☐	☒
b) Hazards to safety from design features (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? (ix)	☐	☐	☐	☒
c) Inadequate emergency access or access to nearby uses? (ix)	☐	☐	☐	☒
d) Insufficient parking capacity on-site or off-site? (ix)	☐	☐	☐	☒
e) Hazards or barriers for pedestrians or bicyclists? (ix)	☐	☐	☐	☒
f) Conflicts with adopted policies supporting alternative transportation (e.g., bus turnouts, bicycle racks)? (ix)	☐	☐	☐	☒
g) Rail, waterborne or air traffic impacts? (ix)	☐	☐	☐	☒
VII. BIOLOGICAL RESOURCES. Would the proposal result in impacts to:				
a) Endangered, threatened, or rare species or their habitats (including but not limited to plants, fish, insects, animals, and birds)? (ix)	☐	☐	☐	☒
b) Locally designated species (e.g., heritage trees)? (ix)	☐	☐	☐	☒
c) Locally designated natural communities (e.g., oak forest, coastal habitat, etc.)? (ix)	☐	☐	☐	☒

Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
d) Wetland habitat (e.g., marsh, riparian, and vernal pool)? (ix)	☐	☐	☐	☒
e) Wildlife dispersal or migration corridors? (ix)	☐	☐	☐	☒
VIII. ENERGY AND MINERAL RESOURCES. Would the proposal:				
a) Conflict with adopted energy conservation plans? (ix)	☐	☐	☐	☒
b) Use non-renewable resources in a wasteful and inefficient manner? (ix)	☒	☐	☐	☐
c) Result in the loss of availabillity of a known mineral resource that would be of future value to the region and the residents of the State? (ix)	☐	☐	☐	☒
IX. HAZARDS. Would the proposal involve:				
a) A risk of accidental explosion or release of hazardous substances (including, but not limited to: oil, pesticides, chemicals, or radiation)? (ix)	☐	☐	☐	☒
b) Possible interference with an emergency response plan or emergency evacuation plan? (ix)	☐	☐	☐	☒
c) The creation of any health hazard or potential health hazard? (vi, vii, ix)	☒	☐	☐	☐
d) Exposure of people to existing sources of potential health hazards? (viii, ix)	☐	☐	☐	☒
e) Increased fire hazard in areas with flammable brush, grass, or trees? (ix)	☒	☐	☐	☐
X. NOISE. Would the proposal result in:				
a) Increases in existing noise levels? (ix, x)	☐	☐	☐	☒
b) Exposure of people to severe noise levels? (ix)	☐	☐	☐	☒
XI. PUBLIC SERVICES. Would the proposal have an effect upon, or result in a need for new or altered government services in any of the following areas:				
a) Fire protection? (ix)	☐	☐	☐	☒
b) Police protection? (ix)	☐	☐	☐	☒
c) Schools? (ix)	☐	☐	☐	☒
d) Maintenance of public facilities, including roads? (ix)	☐	☐	☐	☒
e) Other governmental services? (ix)	☐	☐	☐	☒

Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
XII. UTILITIES AND SERVICE SYSTEMS. Would the proposal result in a need for new systems or supplies, or substantial alterations to the following utilities:				
a) Power or natural gas? (ix)	☐	☐	☐	☒
b) Communications systems? (ix)	☐	☐	☐	☒
c) Local or regional water treatment or distribution facilities? (ix)	☐	☐	☐	☒
d) Sewer or septic tanks? (ix)	☐	☐	☐	☒
e) Storm water drainage? (ix)	☐	☐	☐	☒
f) Solid waste disposal? (xii)	☒	☐	☐	☐
g) Local or regional water supplies? (ix)	☐	☐	☐	☒
XIII. AESTHETICS. Would the proposal:				
a) Affect a scenic vista or scenic highway? (ix)	☐	☐	☐	☒
b) Have a demonstrable negative aesthetic effect? (ix)	☐	☐	☐	☒
c) Create light or glare? (ix)	☐	☐	☐	☒
XIV. CULTURAL RESOURCES. Would the proposal:				
a) Disturb paleontological resources? (ix)	☐	☐	☐	☒
b) Disturb archaeological resources? (ix)	☐	☐	☐	☒
c) Affect historical resources? (ix)	☐	☐	☐	☒
d) Have the potential to cause a physical change which would affect unique ethnic cultural values? (ix)	☐	☐	☐	☒
e) Restrict existing religious or sacred uses within the potential impact area? (ix)	☐	☐	☐	☒
XV. RECREATION. Would the proposal:				
a) Increase the demand for neighborhood or regional parks or other recreational facilities? (ix)	☐	☐	☐	☒
b) Affect existing recreational opportunities? (ix)	☐	☐	☐	☒
XVI. MANDATORY FINDINGS OF SIGNIFICANCE.				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory? (ix)	☐	☐	☐	☒

Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
b) Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals? (ix)	☐	☐	☐	☒
c) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.)	☒	☐	☐	☐
d) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☒	☐	☐	☐

XVII. EARLIER ANALYSES.

Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, one or more effects have been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). In this case a discussion should identify the following on attached sheets:

X a) **Earlier analyses used.** Identify earlier analyses and state where they are available for review.

b) **Impacts adequately addressed.** Identify which effects from the above checklist were within the scope of and adequately analyzed in an earlier document pursuant to applicable legal standards, and state whether such effects were addressed by mitigation measures based on the earlier analysis.

c) **Mitigation measures.** For effects that are "Less than Significant with Mitigation Incorporated," describe the mitigation measures which were incorporated or refined from the earlier document and the extent to which they address site-specific conditions for the project.

Authority: Public Resources Code Sections 21083 and 21087.
Reference: Public Resources Code Sections 21080(c), 21080.1, 21080.3, 21082.1, 21083, 21083.3, 21093, 21094, 21151; *Sundstrom v. County of Mendocino*, 202 Cal.App.3d 296 (1988); *Leonoff v. Monterey Board of Supervisors*, 222 Cal.App.3d 1337 (1990).

Explanation of Checklist Judgments

Following are brief explanations of all answers in the Environmental Checklist Form. For the majority of the "No Impact" responses, a preliminary review shows that these potential effects are not applicable to this project. Part of this preliminary review by the Lead Agency was to evaluate previous environmental reviews and other information sources. (See section XVII of this checklist and the list of citations at the end of the checklist.)

I. Land Use and Planning.

a. No Impact: This issue is not applicable to this project. The project is for consideration of an alternative building material (CPVC pipe) and will not have conflicts with any general plan designations or zoning.

b. No Impact: This issue is not applicable to this project. The project is for consideration of an alternative building material (CPVC pipe) and will not conflict with plans or policies by agencies with jurisdiction over the project.

c. No Impact: This issue is not applicable to this project. The project is for consideration of an alternative building material (CPVC pipe) and will not be incompatible with existing land uses.

d. No Impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not be incompatible with agricultural resources or operations.

e. No Impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not disrupt or divide the physical arrangement of an existing community.

II. Population and Housing.

a. No Impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not cause official regional or local population projections to be exceeded.

b. No Impact: Allowing the use of CPVC pipe could change the cost of housing construction, maintenance, and rehabilitation, which could influence housing costs and rents, and thus indirectly induce growth. The Lead Agency notes that there is disagreement as to whether the use of CPVC would be more or less expensive than the currently approved materials.[iii] This potential consequence of the proposed project is related to a physical change in the existing environment (the expanded use of CPVC

pipe in residential dwellings would be a physical change in the environment of dwellings), but is not an environmental impact under CEQA. Thus, whether housing values and rents are increased, decreased, or are not effected will not be examined in the EIR.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not displace existing housing.

III. Geologic Problems.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not expose people to, or cause fault rupture.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to seismic ground shaking.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to seismic ground failure, including liquefaction.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to seiche, tsunami, or volcanic hazard.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to landslides or mudflows.

f. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to erosion, changes in topography or unstable soil conditions from excavation, grading, or fill.

g. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to subsidence of the land.

h. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to expansive soils.

i. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in, or expose people to unique geologic features.

IV. Water.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not change absorption rates, drainage patterns or the amount of runoff.

b. **Potentially significant impact:** The issue of flooding of residences due to mechanical failure of non-metallic pipe was raised during an earlier analysis.[iv] While this was mainly in reference to materials other than CPVC, the EIR will examine the potential for flooding due to mechanical failure of CPVC pipe in residential dwellings. This will include, but not be limited to mechanical failure in seismic events (earthquakes).

c. **Potentially significant impact:** The issue of leachates from CPVC pipe, solvent cements and primers contaminating surface water was raised in earlier analysis.[v] This potential impact will be addressed in the EIR.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in changes in the amount of surface water in any water body.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in changes in currents, or the course or direction of water movements.

f. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in changes in groundwater quantity.

g. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in alterations in direction or rate of groundwater flow.

h. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in changes in groundwater quality.

i. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a substantial reduction in the amount of groundwater otherwise available for public water supplies.

V. Air Quality.

a. **Potentially significant impact:** The issue of solvent cements and primers used for installation and repair of CPVC pipe contributing to air pollution was raised during an earlier analysis.[vi] The concern was that volatile organic compounds in these materials could evaporate and be precursors of photochemical smog. This potential impact will be addressed in the EIR.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in exposure of sensitive receptors to pollutants, except the potentially significant impact related to photochemical smog, which will be addressed in the EIR.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not alter air movement, moisture, temperature, or cause climate change.

d. Less than significant impact: Some persons may find the odors of the solvent cements and primers used to install and repair CPVC pipe to be objectionable. Similar odors emanate from the solvent cements used in installation and repair in other CPVC pipe uses and other pipe products now in use, for example polyvinyl chloride (PVC) pipe commonly used in residential sprinkler systems. These odors would be of short duration and very localized and would, therefore, not constitute a potentially significant impact.[vii]

VI. Transportation and Circulation.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in increased vehicle trips or traffic congestion.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in hazards to traffic safety from design features or incompatible uses.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in changes to emergency access or access to nearby uses.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in changes in parking capacity.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in hazards to pedestrians or bicyclists.

f. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in conflicts with existing policies supporting alternative transportation.

g. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts on rail, waterborne or air traffic.

VII. Biological Resources.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts to endangered, threatened, or rare species or their habitats.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts on locally designated species.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts to locally designated natural communities.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts to wetland habitats.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts on wildlife dispersal or migration corridors.

VIII. Energy and Mineral Resources.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in conflicts with adopted energy conservation plans.

b. **Potentially significant impact**: Since CPVC is manufactured from petroleum derived precursors, the issue of using these non-renewable resources in a wasteful and inefficient manner will be addressed in the EIR.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in the loss of availability of known mineral resources that would be of future value to the residents of the State.

IX. Hazards.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in any risk of accidental explosion or release of hazardous substances.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not interfere with an emergency response plan or emergency evacuation plan.

c. **Potentially significant impact**: Several issues related to the creation of health hazards or potential health hazards have been raised in relation to the proposed use of CPVC for potable water pipe in residences:

- During earlier analysis it was suggested that materials hazardous to human health might leach from CPVC pipe and solvent cemented CPVC pipe joints into potable water supplies in harmful concentrations.[viii] This potential impact will be addressed in the EIR.

- During earlier analysis it was suggested that workers installing CPVC pipe could be exposed to harmful concentrations of solvents from the solvent cements used. Both dermal and inhalation exposure routes were proposed.[ix] This potential impact will be addressed in the EIR.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in exposure of people to existing sources of potential health hazards. During an earlier analysis the issue of permeation of toxic wastes from contaminated sites into potable water through CPVC pipe was raised.[x] This will not be considered in the EIR: The reason for this is that the proposed project is only for the use of CPVC pipe <u>within</u> residential dwellings, not for burial in potentially contaminated soils. Permeation from contaminated soils is thus not a physical possibility in this project. This issue will not be analyzed in the EIR.

e. **Potentially significant impact**: During earlier analysis it was determined that CPVC pipe is more susceptible to fire damage than metal pipe, that it could allow more rapid spread of fire, and that it could produce toxic gasses when exposed to fire.[xi] The earlier analysis found that these effects were less than significant with mitigation. Since this analysis and the mitigation were for CPVC use in a specific local jurisdiction, the issue of fire damage, fire spread, and toxic gasses during fires will be

addressed in the EIR, to consider whether or not these potential effects would be significant if CPVC is allowed for use statewide.

X. Noise.

a. No impact: In a previous analysis it was suggested that using "plastic" pipe rather than metal pipe could significantly increase noise levels.[xii] This was in reference to use of "plastic" pipe for wastewater and vents, not potable water piping. Another previous analysis of CPVC pipe for potable water supply in residential buildings found that noise would not be a significant impact for this use.[xiii] Since the project at hand is for CPVC pipe use in potable water systems in residences, this potential impact will not be analyzed in the EIR.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in exposure of people to severe noise levels.

XI. Public Services.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new or altered fire protection services.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new or altered police services.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new, or alterations to existing schools.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in significant changes in the maintenance of public facilities.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in significant changes in other government services.

XII. Utilities and Service Systems.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new

systems or supplies of power or natural gas, or substantial alterations to existing power or natural gas systems.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new communications systems, or require substantial alterations to existing communications systems.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new local or regional water treatment or distribution systems, or substantial alterations to existing local or regional water treatment or distribution systems.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new sewer or septic tank systems, or require substantial alterations to existing sewer or septic tank systems.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new storm water drainage systems, or require substantial alterations to existing storm drainage systems.

f. **Potentially significant impact**: During an earlier analysis[xiv] it was suggested that use of CPVC pipe would result in problems in solid waste disposal for demolition debris from structures which used CPVC pipe. This effect will be evaluated in the EIR.

g. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in a need for new local or regional water supply systems, or require substantial alterations to existing local of regional water supply systems.

XIII. Aesthetics.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts to scenic vistas or scenic highways.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in any demonstrable negative aesthetic effects.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in light or glare.

XIV. Cultural Resources.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in disturbance of paleontological resources.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not disturb archaeological resources.

c. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not impact historical resources.

d. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in impacts on unique ethnic cultural values.

e. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not restrict existing religious or sacred uses within the State.

XV. Recreation.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not result in any increased demand for neighborhood or regional parks or other recreational facilities.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not affect any existing recreational opportunities.

XVII. Mandatory Findings of Significance.

a. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or eliminate important examples of major periods of California history or prehistory.

b. No impact: This issue is not applicable to this project. This project is for consideration of an alternative building material (CPVC pipe) and will not have a potential to achieve short-term, to the disadvantage of long-term environmental goals.

c. **Potentially significant impact**: The issues of potential contribution to photochemical smog and to contribute leachates to water have been identified as potentially significant impacts. (See above, IV. c., IX. c., first bullet point, and V. a.) These potentially significant impacts are in a context of cumulative contributions to other impacts on air and water resources. These will be evaluated in the EIR as potentially significant in the context of cumulative impacts on these resources.

d. **Potentially significant impact**: The issue of worker health and safety has been identified as a potentially significant impact. (See above, IX. c. second bullet point.) The issue of leachates in human drinking water has also been identified as a potentially significant impact. (See above, IV. c., and IX. c., first bullet point.) These potentially significant impacts on humans will be evaluated in the EIR.

XVII. Earlier Analysis.

The Lead Agency has used information from earlier analyses when conducting the Initial Study. This information was used to determine that the project may have a significant effect on the environment, and to focus the EIR on those effects which may be significant. These earlier analyses are available for inspection at the offices of the Lead Agency at 1800 Third Street, Sacramento, California 95814, and are discussed below.

The use of CPVC for potable water piping in residential buildings has been the subject of previous environmental reviews under CEQA. Most recently, in 1995, the City of Highland, California, approved the use of CPVC pipe for potable water piping in residential buildings on the basis of a Negative Declaration and Initial Study. (See citation viii below.) Since these Environmental Documents are limited in scope to the City of Highland, they will not be used for approval of this statewide program. Nevertheless, they do adequately address many of the potential environmental effects of the project, and are cited in the Initial Study. Several of the impacts identified in the Initial Study as "Potentially Significant" were not found to be significant in the City of Highland Negative Declaration due to mitigation adopted by the City of Highland. The adequacy of these, and possible additional mitigation measures for the statewide use of CPVC will be evaluated in the EIR, in the event that one or more of the potentially significant effects identified in the Initial Study proves to be significant.

In 1989 the Lead Agency, the California Department of Housing and Community Development, circulated a Draft EIR which included the proposed use of CPVC pipe, among other materials, for potable water use in residential buildings. This previous Draft EIR was never finalized. Given the much broader scope of this previous Draft EIR, and the substantial time which has passed since it was drafted, the Lead Agency has

determined to not finalize it. Nevertheless, this document and comments received on it do help to identify potentially significant effects of the proposed project.

In addition to these earlier environmental reviews under CEQA, other information on the potential environmental effects of CPVC use for potable water piping in residential buildings has been submitted to, or is otherwise available to the Lead Agency, and was used in the preparation of this Initial Study. In particular, the document entitled "CEQA Record, *Richard Cuffe vs. California Building Standards, et al.* San Francisco County Superior Court Case Number 977657" contains information on a number of issues related to CPVC use for potable water piping in residential buildings.

Citations

References cited in the Initial Study. Some of the issues have been raised multiple times. The references cited are intended to be illustrative, not exhaustive. Copies of the documents cited are available for inspection at the offices of the Lead Agency at 1800 Third Street, Sacramento California, 95814.

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[i] Information Bulletin 97-02 (SHL), April 7, 1997, California Department of Housing and Community Development, Division of Codes and Standards, pp. 3-4.

[ii] Superior Court of California, County of San Francisco, "Judgment Granting Peremptory Writ of Mandate, Case Number 977657, March 13, 1997.

[iii] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996, pp. 19-21.

[iv] Comments submitted by the California Pipe Trades Council entitled "Draft EIR Ignores Public Health Dangers and Environmental Hazards of Plastic Pipe," dated November 13, 1989.

[v] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 141-142.

[vi] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 136-138.

[vii] Initial Study, City of Highlands, dated April 1995, p. 15.

[viii] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 52-74.

[ix] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 52-74.

[x] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 80-85.

[xi] Initial Study, City of Highlands, dated April 1995.

[xii] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 142-143.

[xiii] Initial Study, City of Highlands, dated April 1995, p. 10.

[xiv] Comments of the Coalition for Safe Building Materials, on proposed adoption of amendment to California Plumbing Code to authorize use of CPVC pipe, dated February 13, 1996. Appendices, Volume I, pp. 139-141.

file plastic pipe

Message for Bill Brennan

From: Marybel Batjer

Date: Fri, Jun 27, 1997 7:54 PM

Subject: FW:

To: Bill Brennan; Dale Bonner

I spoke to Camden Fri.night; he had just completed a telecon with Rich. Rich restated to Camden that he thought that he had been given the charge by Camden (C) to run the project. He told C. that Agency had taken over...that Agency was calling meetings and making decisions that he had understood from C. had been strickly assigned to him as his responsibility. He said that ,"if Bill wants to be the project manager,than fine, my feelings won't be hurt, but I just want to know who is in charge."
C. said he explained that Agency had an important role /responsibility and that Rich needed to work with us. C. asked Rich that if he were totally left alone, what would his timeline be. (BAD question C.!) Rich outlined that he'd take him a month to meet and put a plan together, and he went on and on. C. stopped him finally and said that such a "plan" would be unacceptable.
Unfortunately, C. told Rich to think things over the weekend and to get back to C. on Monday. C. felt he couldn't slam the door on Rich.
C. said to me that he felt he was in a fight bwt. Agency and HCD. I told him that it certainly did not need to be placed in that light.. ..I asked him to explain to Richard on Monday that HCD was the lead agency, however MB & and Agency are responsible to seeing that the lead agency does its job. Further, that being a lead agency did NOT mean that HE, Richard, was to run the project as a project manager; the project manager needed to have experience with CEQA and expertise in environmental sci. The project manager needed to be able to "talk" to the scientists. C. said he would reinforce these points with Richard. Needless-to-say, C. is equally concerned about our friend.

Richard still seems to be uncertain about what is needed to carry out the job. I will again go over the lead agency job description with Rich on Monday.

Ann Jennings asked me to wait until Monday before talking to Food & Ag....she wanted to check out Rynolds work schedule first. She said that Fish and Game is aother place to look, as well as Health Service. She said that CALTRANS could be VERY helpful in informing us as to process. Oh well, here we go!

From: CMcEfee@GOV.CA.GOV on Fri, Jun 27, 1997 1:15 PM
Subject: RE:
To: Bill Brennan; Marybel Batjer

Demonstrating leadership is one thing -- being an idiot is another. He has a call into me, and I will return it. Stay tuned.

>----------
>From: Bill Brennan[SMTP:bbrennan@smtp.star9gw1.teale.ca.gov]
>Sent: Friday, June 27, 1997 1:36 PM
>To: McEfee, Camden
>Cc: Bill Brennan; Marybel Batjer
>

>Camden: Well, I just had a come to Jesus meeting with Rich Mallory
>regarding
>his performance the other day at the plastic pipe meeting. His retort was
>that you specifically held him back the other day to let him know that he,
>"Rich Mallory" was individually and personally on the line to manage and make
>this thing work. That his job, reputation and balls would be ground to
>nothingness if he failed. He believed that you annointed him with the
>instructions that he was to be his own boss, take nothing from anyone that
>got
>in his way, including anyone at State and Consumer Affairs, and if anyone
>did,
>he was to report directly and immediately to you. Well, I just got in his
>way, and he should be calling you sometime soon.
>
>He claims that he thought he was carrying out the specific instructions you
>gave him to take immediate charge of this matter. He also apologized if he
>misunderstood his role, and is ready and willing to cooperate to make plastic
>pipe for residential use a reality.
>
>More later, but expect his phone call soon. I am off to a Caltrans Tourney.
>

- No vinyl chloride or benzene was detected.
- Other than isolated incidents involving toluene and phthalates at low ppb levels, no other contaminants were found.
- Concentrations of the three cement constituents (tetrahydrofuran, cyclohexanone and methylethylketone) were observed to fall rapidly during the pre-occupancy period, and to continue to decline at a slower rate in the usage period.

1.3 Statement of Qualifications

McKesson Environmental Services, Inc. (MES) was selected by The Vinyl Institute to conduct this study. The MES Engineering Department managed this program while MES Laboratory performed all analytical determinations.

The MES Laboratory Services Department is certified by the California Department of Health Services. The MES Laboratory has participated in several U.S. Environmental Protection Agency Method Validation Studies, and has provided analytical services to the Department of Health and numerous local government agencies and private sector clients.

A summary of qualifications for McKesson Environmental Services is provided in Appendix III at the end of this section.

McKesson results compared w/ NSF 61 single product allowable concentration

THF	0.37 ppm	=	370 ug/L	1/26/96
cyclohexanone	3.0 ppm	=	3000 ug/L	4/26/02
MEK	0.4 ppm	=	400 ug/L	9/10/03

TABLE 10

ANALYTICAL RESULTS

CPVC PIPE LEACHING STUDY

CONCENTRATION in ug/L

SAMPLE ID DUBLIN MUNICIPAL WATER ASSEMBLY "A"	Day 1	Day 3	Day 7	Day 10	Day 14	Day 16	Day 18	Day 20	Day 22	Day 24	Day 27	Day 30	Day 33	Day 36	Day 39	Day 50	Day 63	Day 75
PARAMETER:																		
Chloroform	37	58	24	15	14	13	13	11	10	12	24	15	22	34	23	41	59	40
Bromodichloromethane	35	29	39	44	31	31	31	40	37	36	43	39	40	39	37	65	66	55
Dibromochloromethane	24	12	41	60	41	43	43	72	73	60	44	57	31	31	36	57	36	42
Bromoform	--	0.8	11	17	13	15	16	26	32	22	8	22	4	6	9	10	3	7
Carbon Tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	ND<10	ND<8.2	ND<8.0	6.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tetrachlorethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	ND<2.0
Toluene	ND<0.6	ND<0.5	ND<0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THF	29000	11000	2500	2800	2600	2700	2600	1100	2000	1800	1600	2800	1900	1700	1000	940	890	870
Cyclohexanone	2200	1240	180	190	230	200	180	120	140	120	85	170	130	91	48	43	67	54
MEK	5500	2500	550	600	630	580	540	210	380	370	300	550	340	330	200	180	180	180
DMF	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

-- Not Detected. See stated detection limits.

ND< Value = Detection limit increased to 2 x level found in blank.

B Reported value > 2 x blank value; reported value corrected for blank value.

TABLE 10 (cont'd)

ANALYTICAL RESULTS
CPVC PIPE LEACHING STUDY

SAMPLE ID — CONCENTRATION in ug/L

PROTOCOL WATER ASSEMBLY "A"	Day 1	Day 3	Day 7	Day 10	Day 14	Day 16	Day 18	Day 20	Day 22	Day 24	Day 27	Day 30	Day 33	Day 36	Day 39	Day 50	Day 63	Da 75
PARAMETER:																		
Chloroform	2	2	0.5	0.44	--	--	0.5	--	--	--	--	--	--	--	--	--	--	-
Bromodichloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Dibromochloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Bromoform	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Carbon Tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Methylene Chloride	ND<10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Vinyl Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Tetrachlorethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
Toluene	ND<0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-
THF	22000	14000	4400	4400	2800	4000	3900	2500	3000	3100	2400	3200	1900	1400	1000	1000	1600	690
Cyclohexanone	2400	1510	220	220	270	250	230	180	170	150	110	130	63	28	17	21	51	3
MEK	4700	3300	950	820	550	890	800	520	660	620	420	570	300	180	140	100	220	12
DMF	20	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-

-- Not Detected. See stated detection limits.
ND< Value = Detection limit increased to 2 x level found in blank.
B Reported value > 2 x blank value; reported value corrected for blank value.

TABLE 10 (c'd)

ANALYTICAL RESULTS

CPVC PIPE LEACHING STUDY

SAMPLE ID — CONCENTRATION in ug/L

DUBLIN MUNICIPAL WATER ASSEMBLY "B"	Day 1	Day 3	Day 7	Day 10	Day 14	Day 16	Day 18	Day 20	Day 22	Day 24	Day 27	Day 30	Day 33	Day 36	Day 39	Day 50	Day 63	Day 75
PARAMETER:																		
Chloroform	34	61	28	14	14	13	13	11	11	10	23	16	23	35	23	40	59	38
Bromodichloromethane	34	30	39	46	31	31	32	42	37	37	45	40	40	40	38	68	67	55
Dibromochloromethane	22	12	41	63	41	46	46	75	71	70	51	59	30	32	37	60	39	43
Bromoform	--	0.8	10	17	14	16	17	27	30	28	10	22	3	6	10	11	4	8
Carbon Tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	ND<10	ND<8.2	ND<8.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tetrachlorethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	ND<2.0
Toluene	ND<0.6	ND<0.5	ND<0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THF	6700	9200	2900	2100	2400	2000	2200	1000	1700	1400	1400	2500	1200	1400	860	740	930	840
Cyclohexanone	1000	1070	180	150	190	160	170	100	120	110	73	150	83	71	43	33	51	50
MEK	850	2000	600	400	530	440	450	210	340	280	260	470	200	240	170	140	170	150
DMF	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

-- Not Detected. See stated detection limits.

ND< Value = Detection limit increased to 2 x level found in blank.

B Reported value > 2 x blank value; reported value corrected for blank value.

TABLE 10 (cont'd)

ANALYTICAL RESULTS
CPVC PIPE LEACHING STUDY

SAMPLE ID

CONCENTRATION in ug/L

PROTOCOL WATER ASSEMBLY "B"	Day 1	Day 3	Day 7	Day 10	Day 14	Day 16	Day 18	Day 20	Day 22	Day 24	Day 27	Day 30	Day 33	Day 36	Day 39	Day 50	Day 63	Day 75
PARAMETER:																		
Chloroform	1.5	1.1	0.3	0.47	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Tetrachloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	ND<10	ND<8.2	ND<8.0	ND	7.7	--	5.48	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tetrachlorethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	ND<2
Toluene	ND<0.6	ND<0.5	ND<0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THF	35000	12000	5000	3600	3700	3800	3200	2300	3300	2600	2200	2800	1700	1200	960	1000	1400	920
Cyclohexanone	2100	1240	160	200	230	250	210	160	140	140	91	110	55	22	13	20	40	2
MEK	7400	2600	1100	730	800	800	620	450	670	460	340	460	230	130	120	76	180	12
DMF	13	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-

\- Not Detected. See stated detection limits.

ND< Value = Detection limit increased to 2 x level found in blank.

B Reported value > 2 x blank value; reported value corrected for blank value.

Bill Staack

From: Dave Walls
Sent: Tuesday, September 28, 2004 4:09 PM
To: Bill Staack
Subject: FW: Repiping

Dave Walls, CSA1
State Housing Law Program Manager
Department of Housing and Community Development
Division of Codes and Standards (916) 445-9471

-----Original Message-----
From: Bill Staack
Sent: Wednesday, September 15, 2004 3:14 PM
To: Jim McGowan; Chris Anderson; Dave Walls; Doug Hensel; Kevin Reinertson; Ron Bergeson
Subject: Repiping

I requested from Noveon, Inc any information that had on plumbers repiping homes with metallic pipe problems. They sent me the following information on southern California that was obtained from plumbing companies that repipe.

Orange County	10,000 yearly
LA County	15,000 yearly
San Diego County	10,000 yearly
Riverside County	9,000 yearly
San Bernardino	12,000 yearly
Ventura/Santa Barbara	8,000 yearly
Kern County	4,000 yearly

Orange County Ace Duraflow estimated 90% copper pipe replacement and 10% galvanized.

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Orange County has a large portion not due to population but due to type 2 soil issues. Los Angeles County has a large area with a huge population base and San Diego area has more problems in the costal communities and North County associated with type 2 pitting. Riverside and San Bernardino have a higher percentage of type 1 or water issues and Ventura and Santa Barbara Counties have more of a mix.

Garry Gage
Noveon Inc.

Estimated Southern California Re-pipes

In the past 5 years copper pipe restoration in certain parts of Southern California has captured part of a large re-piping industry. Before restoration most homes were either partially re-piped or completely repiped. Some homes had just hot sides re-piped due to type 2 corrosion and others had complete re-pipes.

Insurance rules: If you have a slab leak in copper piping you must pay a deductible and then get that pipe repaired only. This is first call. On the second call with same problem some Insurance companies will give you a partial or whole re-pipe. Typically on the third problem most insurance companies will re-pipe. So there are a large amount of insurance claims for repairs and re-pipes. Many insurance companies will cancel the homeowners' policy on the third leak. I have worked with Allstate, State Farm, Farmers and many other smaller companies. There is a strong resistance to re-pipe issues due to the cost associated with re-piping. The re-pipe market is large in almost all Southern California counties and Cities.

Orange County has a large percentage of copper problems associated mostly with soil conditions or type 2 pitting. Oftentimes plumbers who do these re-pipe do the whole system not knowing the difference in soil or water problems and sell the homeowners on complete re-pipes. The Orange County Ace Duraflow customer service web site generates over 1000 hits per week and they have a serious backlog issue. They estimate that over 90% of their sales come from copper customers with less than 10% old galvanized issues. The problem is that copper has been in existence since around 1962 and a lot of those homes also needed restoration.

Re-piping contractors are found in abundance throughout the phone directory. Nearly all small to large contractors offer this service associated with also offering leak detection services. One of the largest leak detection services is American Leak Detection who only does re-pipes and leak detections. Below are my estimates based on nearly 24 years field experience as a plumber in Southern California and based on recent conversations I've had with leading plumbing contractors. Please realize that these companies prefer not to release detailed re-pipe information for many reasons.

Estimated re-pipes in Southern California (if you count the restoration and re-pipes)

Orange County.....10,000 yearly
Los Angeles County.....15,000 yearly
San Diego County.....10,000 yearly
Riverside County.....9,000 yearly
San Bernardino County.....12,000 yearly
Ventura/Santa Barbara Counties.....8,000 yearly
Kern County.....4,000 yearly

Garry L. Gage

Noveon, Inc.
PO Box 293171
Phelan, CA 92329-3171

(909) 538-4049 cell
(760) 868-8503 fax

NOVEON

Fax

To:	Bill Strack	From:	Garry Gage
Company:	H.C.D.	Pages:	3
Fax:	916-323-2815	Date:	9/15/01
Re:	Repipes	CC:	

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

I would add about 1/4th to the totals for Northern California.

Thanks

Garry

1/4 (TOTAL) = Northern CA.

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Bill Staack

From: Bob Raymer [rraymer@cbia.org]

Sent: Tuesday, March 01, 2005 5:08 PM

To: Bill Staack

Subject: Revised Data

The housing-start data that I sent you last year has been updated by the Construction Industry Research Board. At present CIRB is indicating that 211,000 dwelling units were constructed in 2004. This means that we produced homes at a rate of 5[illegible] units per day.
If memory serves correctly, I had sent you data some time ago indicating a total of 201,000 units for the year which would have meant a rate of 550 per day. At this point, you can consider the 211,000 figure for 2004 to be very firm with little chance for further revision. I hope this is what you're looking for.

Doug Hensel

From: Bill Staack
Sent: Wednesday, December 01, 2004 2:23 PM
To: Doug Hensel
Subject: FW: Estimate annual use of CPVC for new construction

Importance: High

Doug. I got these estimates from Harry Moos, but as you can see they do not include California.

-----Original Message-----
From: Harry Moos [mailto:Harry.Moos@Noveon.com]
Sent: Tuesday, October 26, 2004 6:26 AM
To: Bill Staack
Subject: RE: Estimate annual use of CPVC for new construction

Bill, in the last 40 years more than (3) billion feet of CPVC pipe has been installed in homes, Condominiums, apartments, and hotels, including (8) million homes. For the last 4 to 5 years of course excluding California due to the deal we would estimate the following: approx 1,000,000. Homes in the last five years in residential construction as in Florida and other states have exploded with the use of CPVC.

-----Original Message-----
From: Bill Staack [mailto:BStaack@hcd.ca.gov]
Sent: Thursday, October 21, 2004 3:18 PM
To: Harry Moos
Subject: Estimate annual use of CPVC for new construction

Harry. Are there estimates in you industry for the amount of CPVC that has been used in new residential construction, (not re-piping as I asked before) in the last 4 or 5 years.

Thanks.

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Doug Hensel

From: Harry Moos [Harry.Moos@Noveon.com]
Sent: Friday, December 03, 2004 8:45 AM
To: Doug Hensel
Subject: CPVC usage

Doug, this is the best estimate I could come up with:

1. Home many homes in California have CPVC in the years of :

   A. 2000, 2,000 homes

   B. 2001, 2,200 homes

   C. 2002, 2,200 homes

   D, 2003, 2700 homes

   E. 2004, 12,000 homes base through November, this includes Multi-family.

2. Number of re-pipes for all materials in California including Copper, Pex, and Flowguard CPVC:

Since 2000 the average is approx 20,000 to 25,000 a year and most early on was copper and CPVC, Ace Dura Flow a company that coats the pipe is claiming they have been getting approx, 1,200 a year using their process. Pex is not the choice of re-pipers as it is to flexible and does not replace existing piping easy as CPVC or Copper.

Doug I hope this helps but these are very conservative figures above.

Noveon a Lubrizol Company

Harry Moos Consultant

4832 Cory Ct

Carmichael, Ca 95608

Doug Hensel

From: Bill Staack
Sent: Wednesday, December 22, 2004 9:00 AM
To: Doug Hensel
Subject: RE: CPVC usage

Thanks Doug.

-----Original Message-----
From: Doug Hensel
Sent: Wednesday, December 22, 2004 9:00 AM
To: Bill Staack
Subject: RE: CPVC usage

I have asked Harry for the info and will forward it to you as soon as I get it.

Doug Hensel
District Representative II
California Department of
Housing and Community Development
Division of Codes and Standards
(916)445-9471 ~ fax: (916)327-4712
dhensel@hcd.ca.gov

SF Environment

Plastic Pipe Alternatives Assessment

by
Mark Rossi, Jamie Harvie and Tom Lent

Prepared by the
Center for Environmental Health

under contract for the
San Francisco Department of the Environment

2/11/2005 Draft

This report is currently undergoing peer review.

DRAFT

For more information contact:

Debbie Raphael
Toxics Reduction Program Manager
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(415) 355-3711

Tom Lent
Healthy Building Network
TLent@healthybuilding.net
510-845-5600

Executive Summary

Plastic pipe is increasingly being used in place of traditional materials (copper, steel, concrete, vitrified clay) in a variety of applications. Lower material cost, ease of installation, resistance to chemicals, resilience and durability are key characteristics that have made plastic pipe popular. However, increasing concerns have been raised in recent years about the environmental profile of plastic pipe. Particular concern has been raised about the chemicals used in plastic pipe production and otherwise associated with the life cycle of these pipes. While sharing a common origin in fossil fuels, each of the different plastics used in pipes is manufactured through different procedures and contains different chemicals with unique environmental characteristics. This report was commissioned by the City of San Francisco to identify key attributes of the different plastic pipe types to assist the City in aligning its pipe purchasing policies with its chemical and other environmental concern policies.

This study seeks to answer the question of whether there are significant differences between the plastics used to manufacture pipes with a focus on priority environmental health impacts and end of life recyclability. No determination is made on whether plastics are either more or less preferable to the traditional materials used to manufacture pipes. Rather the evaluation is for decision-makers interested in understanding the environmental differences between plastics.

In this report, the plastics used to manufacture pipes are analyzed and compared for ***chemical hazards***, ***recyclability*** and ***performance***. The chemical hazard and recyclability assessments evaluate the environmental sustainability of plastics, while the performance assessment gauges the technical, market, and economic viability of the materials in different applications.

Five plastics commonly used in pipes are evaluated:

- Acrylonitrile butadiene styrene (ABS)
- High density polyethylene (HDPE)
- Cross-linked polyethylene (PEX)
- Polypropylene (PP)
- Polyvinyl chloride (PVC and CPVC[1])

The emphasis of the hazard assessment method used in this report is to **prevent pollution at the source by** avoiding materials and processes that use or generate priority hazardous chemicals. Rather than attempting to determine the quantity of all chemicals generated as pollution and minimizing the volume of those discharges, this hazard assessment method guides decision-makers to materials that are less hazardous across their life cycle by **prioritizing the avoidance of chemicals that are chronic human health hazards, persistent, or bioaccumulative.**

The ***chemical hazards*** examined when analyzing the life cycle of these materials include: carcinogenicity, mutagenicity, reproductive toxicity, endocrine disruption, persistence, and bioaccumulative capacity.[2] ***Priority Chemicals*** in this study are hazardous chemicals that have been targeted for reduction or elimination on a select set of US and international governmental lists.[3] In this analysis, therefore, a preferable plastic is one that does not use as input or generate as output a chemical on the referenced governmental chemical hazard lists and that is truly closed loop recyclable with a strong infrastructure to facilitate that recycling.

[1] CPVC – chlorinated polyvinyl chloride. A modified form of polyvinyl chloride that has more chlorine atoms per repeating monomer unit than does the polyvinyl chloride molecule. This extra chlorine gives CPVC strength at higher temperatures than PVC.

[2] This report does not examine all the potential hazards – including ergonomics, flammability, corrosivity, and neurotoxicity – associated with a chemical.

[3] ***Priority Chemicals of Highest Concern*** for this study are those in the Stockholm Convention on Persistent Organic Pollutants, Priority Persistent Bioaccumulative Toxic (PBT) Pollutants and Priority Chemicals lists by the US Environmental Protection Agency (USEPA) and Chemicals for Priority Action by the Oslo-Paris Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR).

The analysis of the existing data leads to four primary conclusions:

- HDPE and PP are the most environmentally preferable plastics currently used to manufacture pipes under this chemical hazard and recyclability based analysis with no significant distinction between them. Yet even these plastics have their environmental downsides.
- HDPE, PP, and PEX create fewer chemical hazards of high concern across their life cycles than ABS and PVC.
- Plastic pipes are currently seldom recycled. Yet of the plastics used to manufacture pipes, a few general trends emerged. HDPE and PP are the most recyclable and recycled of the plastics (used in pipes). While ABS is recyclable, the recycling markets are small. PEX is inherently difficult to recycle. Finally, while PVC is recyclable under some circumstances, it is considered a contaminant in many recycling programs and its use is increasingly avoided in the automotive sector.
- Plastic pipe alternatives exist in the Prefer category in this analysis (HDPE and PP) that perform equal to or better than the plastics in the Avoid and Concern categories (PVC, ABS and PEX) for each of the pipe applications studied. Availability of preferable alternatives is good in North American markets with the exception of drain-waste-vent (DWV) applications The entry of new PP and HDPE products, with encouragement from forward looking environmentally preferable purchasing policies, is expected to expand availability of preferable alternative options in the North American market for all applications, including DWV.

All the plastic materials examined here have a common raw material origin in crude oil and natural gas. The extraction and refining of oil and gas generate Priority Chemical byproducts. All the plastics examined here, therefore, share a common set of chemical hazards from these processes.

PVC is slightly different than the other plastics because 57% of the weight of raw PVC resin (before additives) is from chlorine manufactured from brine (salt water) instead of from petrochemicals. Chlorine manufacture, however, also creates a similar set of Priority Chemical byproducts. Neither chlorine manufacturing nor oil and gas refining is a more environmentally preferable production system. Therefore the environmental differences between plastics emerge most significantly after the raw material extraction and refining stages. In this analysis, ABS and PVC stand out for their unique association with Priority Chemicals of Highest Concern throughout the rest of their life cycles.

PVC is the only plastic examined in this report to have persistent organic pollutants (POPs) targeted for elimination by the Stockholm Convention throughout its life cycle – that is, after the extraction and refining stages that all plastics share. Throughout the manufacture of PVC, dioxins, furans, hexachlorobenzene, and PCBs continue to be unavoidably produced, primarily because of its chlorine content.

Dioxins are further associated with the combustion of PVC products both during the use phase in accidental building and vehicle fires and at the end of life in incineration and landfill fires.

The unique toxicity of these chemicals, along with their persistent and bioaccumulative nature, has made them a top international priority for elimination[4] . PVC is also the only plastic examined here to have OSPAR Chemicals for Priority Action (organotins, lead, and possibly cadmium) in the final product itself.

Both ABS and PVC differ from the other plastics in their use of carcinogens[5], mutagens, reproductive/developmental toxicants, and endocrine disruptors, either as inputs into the manufacturing process and/or as inputs into the final product.[6]

Recyclability is evaluated primarily on indicators from current recycling markets and evaluations from parallel industries utilizing these plastics. Little recycling is being done with any plastic pipes. All of the plastics are theoretically recyclable and token plastic pipe recycling programs exist for each[7]. However there are significant moves away from PVC, because it is difficult to recycle, and toward the polyolefins

[4] Stockholm encourages product substitution as a method to eliminate these chemicals, reinforcing the importance of prevention through establishing preferences rather than through risk assessment based pollution management.
[5] All of the polymers do use one carcinogen - carbon black - for pipes that may be exposed to UV (ultraviolet) light.
[6] Note that the analysis is limited to the chemical class level for many of the additives used to manufacture plastic pipes as the specific chemical data is considered proprietary by manufacturers.
[7] Although for PEX the only known programs are waste to energy conversion, not true recycling.

(HDPE and PP), with ABS somewhere in the middle. The data indicate that the markets for recycling HDPE and PP will be more robust than PVC and PEX in the future with ABS less certain.

Performance is evaluated on installation, cost, availability and chemical resistance, durability, life span and other related issues. Use of PEX is restricted to relatively small diameter indoor water distribution applications and ABS is generally only used for DWV applications. PVC, PP and HDPE all perform satisfactorily in all applications. Availability is good for all types except for PP in North America.

Table 1 summarizes the results of the analysis and the conclusions of this report.

The hazard and recycling assessments clearly indicate that HDPE and PP are more environmentally preferable than PVC. ABS and PEX occupy a middle ground of concern between PVC at least preferable and HDPE / PP at most preferable. ABS is in the middle ground because of its better recycling profile than PVC. While PEX is preferable to ABS and PVC on chemical hazards, questions remain about its recyclability.

Performance characteristics are generally not an obstacle to using at least one of the polyolefins (HDPE, PP or PEX) to replace the PVC and ABS materials in each application and market availability is growing in all areas. DWV is the only area with market availability obstacles significant enough to slow down replacement at this time.

Table 1. Summary of Plastic Pipe Environmental Preferability Analysis

	Avoid	Concern		Prefer		
	PVC	**ABS**	**PEX**	**PP**	**HDPE**	**Preferable**
Summary of chemical hazard & recyclability assessments	•worst chemical hazard •poor recyclability	•more chemical hazard •low recycling	•less chemical hazard •very limited recyclability	•less chemical hazard •good recyclability	•less chemical hazard •good recyclability	Truly preferable plastic pipes do not yet exist
--- Chemical Hazard Assessment ---------						
Stockholm POPs (outputs after refining)	•Dioxins / Furans •tetrachloro benzene, PCB	+ none	+ none	+ none	+ none	
OSPAR & USEPA PBT & Priority Chemical (inputs)	•Cadmium •lead •organotins	+ none	+ none	+ none	+ none	
Chronic toxicants; Carcinogens, mutagens, developmental or reproductive toxicants or endocrine disruptor (inputs)	•Cadmium •Carbon black •EDC •Lead •organotins •phthalates •VCM	•Carbon black •styrene •vinyl chloride •Benzene •carbon black •Lead •phthalates •styrene •vinyl chloride	•Carbon black	•Carbon black	•Carbon black	
Other PBT Outputs	•many	•many	•many	•many	•many	
--- Recyclability Assessment-------						
Summary recycling markets and recyclability assessment	•Little recycling •Considered contaminant in multi-pass recycling	Recyclable but small markets	•Very limited •Only recycled as filler in other products •Can never be closed loop recycled	+ Established post consumer recycling markets (automotive)	+ Established post consumer recycling markets (bottles)	-
--- Performance / Availability Assessment--------						
- Water distribution	Good/Good	Not used/NA	Good/Good*	Good/Poor*	Good/Good*	
- Drain/Waste/Vent	Good/Good	Good/Good	Not used/NA	Good/Poor	Not used/NA	
- Sanitary sewer	Good/Good	Not used/NA	Not used/NA	Good/Poor	Good/Good	
- Storm sewer	Good/Good	Not used/NA	Not used/NA	Good/None	Good/Good	
- Irrigation & drainage	Good/Good	Not used/NA	Not used/NA	Good/None	Good/Good	
- Irrigation & drainage	Good/Good	Not used/NA	Not used/NA	Good/Poor	Good/Good	

*PEX is used only in small diameter piping primarily for water distribution and radiant systems in buildings. HDPE for water distribution is used primarily in larger diameter piping outside the building. PP is just beginning to be marketed in North America

Introduction

Plastic pipe is increasingly being used in place of traditional materials (copper, steel, concrete, vitrified clay) in a variety of applications. Lower material cost, ease of installation, resistance to chemicals, resilience and durability are key characteristics that have made plastic pipe popular. However, increasing concerns have been raised in recent years about the environmental profile of plastic pipe. Particular concern has been raised about the chemicals used in plastic pipe production and otherwise associated with the life cycle of these pipes. While sharing a common origin in fossil fuels, each of the different plastic pipe polymers is manufactured through different procedures and contains different chemicals with unique environmental characteristics. This report was commissioned by the City of San Francisco to identify key attributes of the different plastic pipe polymers to assist the City in aligning its pipe purchasing policies with its chemical and other environmental concern policies.

This report surveys currently available data about chemicals associated with the life cycle of five major polymers commonly used in plastic pipes (ABS, HDPE, PEX, PP, and PVC). It assesses each polymer type by the characteristics of chemicals associated with it - such as persistence, bioaccumulation, carcinogenicity and reproductive toxicity - and whether any of those chemicals have been identified on a select set of national and international governmental lists as key chemicals of policy concern. The report also briefly looks at end of life options for recycling of the different pipe polymers. Then performance of each of the plastics pipe polymers is evaluated for a variety of primary uses.

The report concludes with recommendations for pipe polymers to avoid based upon particularly poor environmental profiles where alternatives exist that perform at least equally well.

Assessment protocol

The five plastic pipe polymers compared are:

- Acrylonitrile butadiene styrene (ABS)
- High density polyethylene (HDPE)
- Cross-linked polyethylene (PEX)
- Polypropylene (PP)
- Polyvinyl chloride (PVC, CPVC[8])

The applications assessed are:

- Water distribution
- Drain Waste and Vent (DWV)
- Sanitary Sewer
- Storm Sewer
- Irrigation and Drainage
- Duct and conduit

The analyses of hazards, recyclability, and performance are designed to assist the City in aligning its pipe purchasing policy with four key City values:

- **Reducing chemical hazards:** The City has taken a series of measures to reduce the toxic hazards associated with its operations in the City and in the larger environment beyond the City limits. Particularly relevant to this analysis is the City and County Commission on the Environment's Dioxin Resolution (No. 021-098-COE), which resolved to designate dioxin pollution as a high priority for elimination. This report identifies the key environmental health concerns associated with the chemicals used and released in the life cycle of each pipe material.
- **Precautionary principle:** The City of San Francisco has committed to identifying areas of its purchasing policy that impact issues where threats of serious or irreversible damage to people or natural systems exist. Plastic pipes have been identified as one of those areas due to the chemical releases associated with polymer manufacture, use and disposal. This report provides the careful analysis of alternative plastic pipes that the precautionary principle requires, using the

[8] The closely related chlorinated polyvinyl chloride or CPVC, used for higher temperature water delivery pipes, is considered a variant of PVC and not separately treated for this analysis.

best science available to help the City select materials that present the least potential threat to human health and natural systems across their life cycle[9].

- **Zero waste:** The assessment evaluates recyclability for each of the materials to help the City move toward its goal of realizing a zero waste materials stream.
- **High performance**: The assessment identifies relative performance issues for each plastic pipe polymer to assist the City in assuring that it uses materials that will perform well, be durable, cost effective and last in their application.

The final summary evaluation is a qualitative analysis based upon absolute screening criteria, not a quantitative impact analysis.

The resulting evaluation:

- **Characterizes chemical hazards** across the life cycle of pipes. The goal is to eliminate the use of plastics that contribute to key environmental health concerns. This is assessed by screening the life cycle of the target plastic polymers and their additives for the use or generation of chemicals listed in the Stockholm POPs and OSPAR agreements and identified on US EPA, California Proposition 65, and other key governmental lists. The plastics are then categorized into a hierarchy of concern based upon this hazard screening.
- **Characterizes recycling** options at the end of life, looking at both current recycling rates and potential recyclability, including compatibility with other recycling streams. The plastics are categorized for preferability in this area with the goal to maximize potential for reuse and recycling and minimize waste.
- **Creates a hierarchy** of plastic pipe types, bringing together the results of the screening criteria applied to these chemical hazard and recyclability profiles. Pipe types are clustered into Avoid, Concern and Prefer categories. In this analysis, the ideal preferable plastic is one that does not use as input or generate as output a chemical identified on the referenced governmental priority chemical lists and that is truly closed loop recyclable with a strong infrastructure to facilitate that recycling.
- **Summarizes** the applicable **performance** characteristics for each pipe type and addresses how they apply to different typical applications.
- **Assesses performance** in each pipe application category to determine if pipes made from polymers which rate better on the chemical hazard and recyclability screening can be substituted for the polymer types identified for avoidance.

Hazard Assessment

Introduction

The assessment focuses on the life cycles of the pipe products from organic chemical production to end-of-life disposal[10]. This is a qualitative life cycle hazard assessment[11] which identifies the use and generation of toxic, persistent, or bioaccumulative chemicals associated with each material. Because the purpose of this assessment is to be used as a guide for **preventive and precautionary action**, the assessment is based upon identifying the presence rather than volume of toxic, persistent, or bioaccumulative chemicals in the material's life cycle. The primacy of **pollution prevention** as the method for managing toxic chemicals was established by the Pollution Prevention Act of 1990:

> The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled

[9] For more discussion of the precautionary principle, see Appendix 1

[10] The reasons for separate handling of the initial stages of raw materials extraction and processing are explained later in the text under *Inventorying Inputs and Outputs in the Life Cycles of the Plastics*.

[11] For further discussion of the difference between a life cycle hazard assessment and other forms of life cycle assessments (LCA) see Appendix 1

should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

The emphasis of the analytic method used in this report is to **prevent pollution at the source**, avoiding materials and processes that use or generate the most hazardous chemicals. Rather than attempting to determine the quantity of all chemicals generated as pollution and minimizing the volume of those discharges through end-of-pipe treatment, **this assessment method guides decision-makers to deal with pollution problems through substitution with materials that use and generate as byproduct across their life cycle, chemicals that are less hazardous -- prioritizing the avoidance of chronic human health toxicants, persistent chemicals, or bioaccumulative chemicals.**[12]

To achieve this goal we:

1. Inventory:
- *Inputs*: the chemicals that are used as feedstocks or intermediaries in production of each of the products and
- *Outputs*: those chemicals that are byproducts from the production, use, or disposal of the material.

2. Compare:

- chemical inputs and outputs against a set of Priority Chemicals of Highest Concern, primarily persistent bioaccumulative toxic (PBT) chemicals, targeted by national and international governmental agreements for elimination (see lists below) and
- chemical inputs against governmental chronic toxicant lists (carcinogens, mutagens, reproductive toxicants, and endocrine disruptors) and very persistent or very bioaccumulative chemicals.

3. Prioritize:

- Order plastic pipe materials on the basis of avoidance of key chemicals of concern from each list.

Priority Chemicals of Highest Concern

This assessment first identifies Priority Chemicals of Highest Concern based upon the following four lists of chemicals identified and prioritized for reduction by government bodies due their potential to damage human and environmental health:

- **Stockholm Convention on Persistent Organic Pollutants** (POPs)[13], which is a short list of very persistent, bioaccumulative, and toxic organic chemicals targeted for phase-out by international agreement. The U.S. Government has signed, but not ratified, the Stockholm Convention.
- The **US Environmental Protection Agency's Priority (EPA's) Persistent and Bioaccumulative Toxic (PBT) Chemicals**[14]. PBTs that have been identified by the EPA for national action plans.
- **Oslo-Paris Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) List of Chemicals for Priority Action** [15] managed by the European Commission. Chemicals on the OSPAR list are of high concern for water toxicity.
- The **US EPA Priority Chemicals**[16] list targeted for reduction in products and wastes in its National Partnership for Environmental Priorities (NPEP).

[12] For further discussion of the issues behind the choice of precaution, pollution prevention and hazard assessment versus risk assessment or life cycle assessment (LCA) see Appendix 1.
[13] The text of the Stockholm Convention can be found at: http://www.pops.int/documents/convtext/convtext_en.pdf
[14] The list of priority PBT chemicals for which the USEPA is developing national action plans can be found at: http://www.epa.gov/opptintr/pbt/
[15] The list of chemicals identified by the OSPAR Commission for priority action can be found at: http://www.ospar.org/eng/html/
[16] The USEPA NPEP list can be found at: http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm

The chemicals associated with each list are identified in Appendix 2.

Chronic Toxicants as well as Very Persistent & Very Bioaccumulative Chemicals

Chronic toxicants in this assessment refer to chemicals associated with long-term chronic health effects or effects at sub-acute exposures. This assessment is based upon chronic toxicants and very persistent and/or bioaccumulative chemicals listed on the following already scientifically established lists:

Carcinogens are any chemical listed as such by the:

- International Agency for Research on Cancer (IARC)[17]
- U.S. National Toxicology Program[18]
- European Union in Consolidated List Directive 76/769/EEC [19]
- California Office of Environmental Health Hazard Assessment (OEHHA) for Proposition 65[20]

Mutagens, which can cause inheritable genetic damage, are any chemical listed by the European Union as a Category 1 or 2 mutagen in EU Consolidated List Directive 76/769/EEC[21].

Reproductive or developmental toxicants are any chemical listed by the European Union as Category 1 or 2 reproductive toxicant in EU Consolidated List Directive 76/769/EEC or listed as a reproductive/developmental toxicant under California Proposition 65.

Endocrine disruptors are any chemical listed by the European Union as a Category 1 or 2 endocrine disruptor in EU Consolidated List Directive 76/769/EEC. To be a Category 1 endocrine disruptor the chemical must have at least one study providing evidence of endocrine disruption in an intact organism. Category 2 endocrine disruptors have the potential for endocrine disruption.

Very persistent or very bioaccumulative chemicals are those listed by the Swedish National Chemicals Inspectorate's (Kemi)[22]. The European Union defines "very persistent chemicals" as chemicals that have a half-life of greater than 60 days in water, or greater than 180 days in marine or freshwater sediment, or greater than 180 days in soil.[23] The European Union defines "very bioaccumulative" chemicals to have a bioconcentration factor for aquatic organisms of greater than 5000.[24] The European persistence lists do not include metals that are by nature infinitely persistent.

Inventorying Inputs and Outputs in the Life Cycles of the Plastics

Inputs: Primary raw materials: All the materials assessed here share a common primary raw material resource base: they are manufactured, at least in large part, from fossil fuels. The primary chemicals used to produce ABS, HDPE, PEX, and PP are derived from natural gas and crude oil.[25] The primary chemicals used to manufacture PVC are derived from a combination of these same fossil fuels and chlorine gas manufactured from brine (salt water). Chlorine makes up 57% of PVC in its raw pellet state. Each of these plastics also generally contains a range of additives discussed in further detail below.

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[17] The list of IARC evaluations can be found at: http://www-cie.iarc.fr/monoeval/grlist.html
[18] The US National Toxicological Program's Report on Carcinogens can be found at: http://ntp-server.niehs.nih.gov
[19] The consolidated version of Annex I of Directive 76/769/EEC (currently in force) including a consolidated list of CMR substances can be found at: http://europa.eu.int/comm/enterprise/chemicals/legislation/markrestr/index.htm
[20] The list of chemicals as known to the State of California to cause cancer or reproductive toxicity by the California Office of Environmental Health Hazard Assessment (OEHHA) is listed at: http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html
[21] There is no equivalent US list for mutagenicity, however mutagens may be searched at GENETOX & Chemical Carcinogenesis Research Information System, http://sis.nlm.nih.gov
[22] Swedish National Chemicals Inspectorate (Kemi) webpage: http://prio.kemi.se.
[23] Swedish National Chemicals Inspectorate (Kemi) webpage: http://prio.kemi.se. The International Joint Commission (IJC www.ijc.org) adopted an even more conservative definition of a "persistent toxic substance:" any toxic substance that bioaccumulates in the tissue of living organisms, or any toxic chemical that has a half-life greater than eight weeks (56 days) in any medium (water, air, sediment, soil, or living thing).
[24] Swedish National Chemicals Inspectorate (Kemi) webpage: http://prio.kemi.se.
[25] Coal-based byproducts such as coke gases (gases produced when converting coal into coke) are another potential raw material source of feedstocks for plastics. However, in the U.S., natural gas and crude oil are the overwhelming source of raw materials for plastics' feedstocks, therefore coal processes are not included in this analysis.

Since ABS, HDPE, PEX, and PP share a common petrochemical resource base, material selection between them will have no effect on avoidance of chemicals from raw materials extraction and primary chemical production. PVC shares the same petrochemical resource base as ABS, HDPE, PEX, and PP. The difference with PVC arises due to its chlorine content - 57% of the weight of raw PVC (before additives) is from chlorine manufactured from brine (salt water) instead of from petrochemicals. Appendix 3 lists the Priority Chemical outputs from chlorine production, fossil fuel extraction and refining for comparison[26]. Chlorine production has POPs outputs that aren't associated with fossil fuels (PCBs and hexachlorobenzene) while fossil fuels have POPs outputs not associated with chlorine production (aldrin and DDT). Both also have outputs in the other categories of Priority Chemicals of High Concern (US EPA PBTs and OSPAR and EPA Priority Chemicals). Therefore, neither crude oil refining or chlorine production is environmentally superior; both have significant priority chemical hazards associated with their output byproducts. It should be noted that chlorine production has a very serious mercury problem associated with it[27] and that chlorine itself is a highly toxic material.

This comparative analysis therefore focuses on the life cycle concerns after the initial raw material processing stage; that is after the raw material extraction, crude oil refining, natural gas processing, and chlorine production.

The assessment begins with an inventory of the principal organic chemicals used in the manufacture of the five plastics. Table 2 lists those chemicals for each plastic.

Table 2. Principal Organic Feedstocks Used to Manufacture Primary Pipe Polymers

PVC	ABS	PEX	PP	HDPE
Ethylene	Ethylene	Ethylene	Propylene	Ethylene
Ethylene dichloride	Benzene			
Vinyl chloride monomer	Ethylbenzene			
	Styrene			
	Acrylonitrile			
	1,3-Butadiene			

Inputs: Additives: All petrochemical plastics require additives to either facilitate the manufacturing process or to impart specific properties to the final product. The types of additives commonly used in plastic pipes include: antioxidants, antistatic agents, lubricants, ultraviolet (UV) stabilizers, and heat stabilizers. The specific additives used in plastic products, including pipes, are proprietary data and can vary widely among manufacturers; hence complete information was not available for this analysis.[28] Generic formulations that listed specific chemicals were found only for PVC sewer pipes used in Europe (see Appendix 4).

While specific chemical formulations for the additives used in each plastic pipe polymer were not available for this analysis, substantial generic data on additive practices were collected and assessed.

This report:

- Identifies the types of additives used in the manufacture of the plastic pipes: for example, UV light stabilizer.[29]

[26] There are no known Priority Chemical outputs from brine production but there is insufficient data available for conclusion in this analysis.

[27] Nine chlor-alkali plants producing chlorine for PVC manufacture use mercury cell technology. Serious discrepancies and purchases indicate that the plants were not able to account for 65 tons of mercury in 200, more than emitted by all coal fired power plants. U.S. Senate Committee on Environment and Public Works "Senators Call On EPA To Document The Fate Of 65 Tons Of Toxic Mercury" http://epw.senate.gov/pressitem.cfm?party=dem&id=221813

[28] For example, in the case of ABS polymers, "Different manufacturers produce and process ABS significantly differently. Therefore, the selection of stabilizers has to be checked carefully for each process and application." Zweifel, 2000 p.78

[29] Sources include: *Chemical Economics Handbook*, "Plastics Additives" section by Modler, et. al. (1997); and the *Plastics Additives Handbook*, edited by Hans Zweifel (2000).

- Identifies the classes of chemicals used within each additive category: for example, benzophenone light stabilizers for the additive UV light stabilizer.[30]
- Identifies specific chemicals used as additives for specific polymers. For example, the UV light stabilizer 4-dodecyloxy-2-hydroxybenzophenone has been used as an additive in the manufacture of all five plastics considered in this report (ABS, HDPE, PEX, PP, and rigid PVC).[31] However, no data were located specifying the types of products using 4-dodecyloxy-2-hydroxybenzophenone.

The types of additives used to manufacture pipe grade polymers include:

- Lubricants and UV light stabilizers in all five plastics.
- Antioxidants and antistatic agents in ABS, HDPE, PEX, and PP.
- Stabilizers in PVC.

Carbon black is a common UV light stabilizer used in the manufacture of plastic pipes.

See Appendix 5 for a complete listing of classes and where they are used.

Note that the analysis is limited in scope on the specific additives used to manufacture each type of plastic pipe as this data is considered proprietary by manufacturers. To fully assess the relative toxicity of the polymers the City of San Francisco could collect data on the specific additives used in the manufacture of pipes. Due to the proprietary nature of this information, it is likely that the City of San Francisco would need to sign non-disclosure agreements or use an independent third party vehicle to gather and evaluate the data without making it subject to public disclosure.

Outputs: The toxic outputs - the releases of pollutants to air and water - are then inventoried for each stage of production of the principal feedstocks as well as for polymerization and compounding of the plastics. To inventory the full scope of pollutants generated and released during production, even those chemicals released in small quantities,[32] this inventory uses the raw data tables in the life cycle assessment study completed by Tellus Institute.[33] The data tables in the Tellus study are quite useful in identifying pollutants that are present in the wastewater and air emissions from manufacturing processes, but that do not appear in the US EPA's Toxic Release Inventory (TRI) due to falling under the TRI's emissions reporting threshold of 10,000 pounds.

Note that in this assessment all inputs into manufacturing– both principal feedstocks and known additives (or additive classes where the exact additives are not known) -- are included. For outputs, however, only the pollutants from principal feedstocks are identified and assessed. The pollutant outputs from the production of additives have not been identified nor assessed.

Transportation: Inputs and outputs to transportation of pipes and their feedstocks are not included in the scope of this assessment. It is assumed that selection of plastic type will not consistently or inherently affect the type of transportation modes or fuel types. Therefore the chemical hazard of transportation inputs and outputs will not be affected by plastic type selection.

Installation: Chemicals associated with the pipe installation process are also not formally included in this assessment. It should be noted, however, that PVC and ABS use solvent based systems with known chronic toxicants[34], whereas the polyolefins exclusively utilize mechanical or thermal joining methods with no direct chemical inputs. This is not expected to change the rankings as it parallels the hazards identified elsewhere in the life cycle.

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[30] Ibid.
[31] Radian Corporation, 1987. Radian Corporation. 1987. *Chemical Additives for the Plastics Industry: Properties, Applications, Toxicologies.* Park Ridge, NJ: Noyes Data Corporation.
[32] For example, below Toxics Release Inventory reporting thresholds.
[33] Tellus, 1992. While the data in the Tellus Institute report is from the 1980s, it represents the most comprehensive, publicly available database that includes the soup of pollutants released from these processes at very low levels.
[34] Common elements of PVC pipe cement include tetrahydrofuran (suspected endocrine and developmental toxicant with inadequate carcinogenicity data to classify), methyl ethyl ketone (another (suspected endocrine and developmental toxicant), and cyclohexanone (another (also a suspected developmental toxicant) and PVC resin. ABS cement typically consists of methyl ethyl ketone and ABS resin

Hazards Assessment of the Chemicals

Priority Chemicals of Highest Concern: The assessment compares the inventory of chemical inputs and outputs against the Chemicals of Highest Concern (Stockholm POPs, EPA PBTs, and EPA/OSPAR Priority Chemicals). For the five plastic polymer life cycles, these chemicals are primarily found as pollutant outputs: the pollution from manufacture, use and disposal.

Appendix 3 details where in the life cycle of the five plastics these Chemicals of Highest Concern to governments are created as pollutant outputs.

The results of this analysis are as follows:

- **Inputs**: Only PVC uses Chemicals of Highest Concern in manufacturing– the additives organotins, lead, and cadmium, which are OSPAR Chemicals for Priority Action.
- **Outputs (byproducts)**: All of the plastics have both US EPA Priority PBT pollutants and OSPAR Chemicals for Priority Action associated with their life cycle: in the wastewater effluent from the manufacture of petrochemical feedstocks.

  PVC pipes are alone, however, in having Stockholm Convention POPs (dioxins, furans, PCBs, and hexachlorobenzene), as outputs in their life cycle beyond the initial raw material processing stage.

Chronic Toxicants, Persistent Chemicals, or Bioaccumulative Chemicals: The assessment then compares the inventory of chemical inputs to specific chemical hazards -- persistence, bioaccumulative capacity, and chronic toxicity -- for the primary organic chemical feedstocks and additives.

Appendix 6 details the toxicity of known inputs into each of the plastics.

The results include:

- All of the plastic pipes use a carcinogen (carbon black) for applications where the pipe may be exposed to UV light.
- Otherwise, ABS and PVC alone use:
  - carcinogens,
  - mutagens,
  - reproductive/ developmental toxicants, and
  - endocrine disruptors

  as either inputs into the manufacturing process and/or as inputs into the final product, even for non-UV protected product.

Note that unlike with PVC, where there are classes of chemicals used as stabilizers that are clearly hazardous (e.g., cadmium compounds, lead compounds and organotins), there are no such clearly hazardous classes of chemical additives used in ABS, HDPE, PEX, and PP pipes. For example, ABS, HDPE, PEX, and PP all use phenolic-based antioxidants. Unlike the lead compounds used in PVC pipes, hazards have not been identified for phenolic-based chemicals as a class. There is a phenolic-based antioxidant that is known to be an endocrine disruptor, bisphenol A. However, the only evidence found on the use of bisphenol A as an antioxidant states that it is used in PVC production[35].

This study evaluates the plastic manufacturing process inputs against the listings for both
A) the identified Chemicals of Highest Concern and
B) persistence, bioaccumulative capacity, and chronic toxicity.

The outputs, however, are only compared for Chemicals of Highest Concern. Since all of the plastics examined in this report have pollutant outputs that include a large number of additional chemicals that are persistent, bioaccumulative, or toxic, further evaluation from a chemical hazard screening perspective did not reveal any significant differences among the plastics.

[35] Noyes, 1987 note there is also some evidence that bisphenol A may also be used as a flame retardant in ABS, although it is unknown if this occurs in pipes.

Summary and Findings of the Hazards Assessment

Table 3 summarizes the data collected concerning the life cycle hazards to human and environmental health associated with the five plastics commonly used in pipes: ABS, HDPE, PEX, PP, and PVC.

None of the plastics can be characterized as completely environmentally sound from this hazards assessment:

- **Inputs**: All of the plastics -- **ABS, HDPE, PEX, PP, and PVC** -- use the **carcinogen carbon black** for pipes that may be exposed to UV light
- **Outputs**: All the plastic piping materials examined here -- **ABS, HDPE, PEX, PP, and PVC** -- have both **US EPA Priority PBTs and OSPAR Chemicals for Priority Action** pollutant outputs associated with their life cycle: these occur in the wastewater effluent from the manufacture the petrochemical feedstocks used to make the plastics. All of the plastics also have a significant number of other listed persistent bioaccumulative or toxic outputs.

ABS and PVC, however, stand out for their hazards due to their unique association with key chemicals of concern in their life cycles:

- **Inputs: ABS and PVC** alone use **carcinogens**[36]**, mutagens, reproductive/developmental toxicants, and endocrine disruptors** either as inputs into the manufacturing process and/or as inputs into the final product, even for non UV protected product. **PVC** is the only plastic examined here to use **OSPAR Chemicals for Priority Action** in the final product itself.
- **Outputs: PVC pipes** are the only plastic pipe to have **Stockholm Convention POPs** (dioxins, furans, hexachlorobenzene and PCBs) associated with their life cycle after petroleum refining.[37]

ABS and PVC are considered environmentally less preferable in this analysis than HDPE, PEX, and PP because of their use of chronic toxicants as inputs in production that the other plastics avoid altogether. **PVC is judged less preferable than ABS** due to its unique association with outputs on the highest priority list (Stockholm POPs) throughout its life cycle (in the manufacture of its feedstocks and associated with the incineration of PVC products and accidental building fires) and for its use of US EPA and OSPAR Priority Chemicals as inputs. There is no differentiation between the other three plastics in this analysis. Table 3 summarizes the hazard assessment.

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[36] As noted above the other plastics do use one carcinogen – carbon black – for UV protected pipe.
[37] Note that this analysis did not include transportation impacts as described above.

Table 3. Plastic Pipe Hazard Assessment – Chemicals of Highest Concern					
	Avoid	High Concern	Moderate Concern		
	PVC	ABS	PEX	PP	HDPE
Summary chemical hazard assessment	•EPA PBT & •EPA/OSPAR Priority outputs plus •Stockholm/OSPAR POP outputs & •EPA/OSPAR Priority inputs & •Additional chronic toxicant inputs &	•EPA PBT & •EPA/OSPAR Priority outputs plus additional •Chronic toxicant inputs	•Significant EPA PBT & EPA/OSPAR Priority outputs	•Significant EPA PBT & EPA/OSPAR Priority outputs	•Significant EPA PBT & EPA/OSPAR Priority outputs
Chemicals Of Highest Concern On Regulatory Target Lists – Process Inputs					
Stockholm POPs					
US EPA PBT					
US EPA Priority Chemical	Cadmium, Lead				
OSPAR	Cadmium, Lead Organotins,				
Chemicals Of Highest Concern On Regulatory Target Lists – Pollution Outputs (post initial raw material processing)					
Stockholm POPs	Dioxins, Furans, PCB Hexachlorobenzene,				
US EPA PBT	Dioxins, Furans, Benzo(a)pyrene, Hexachlorobenzene, Hg, PCB, OCS	Benzo(a)pyrene, Hg, Lead	Benzo(a)pyrene, Hg	Benzo(a)pyrene, Hg	Benzo(a)pyrene, Hg
US EPA Priority Chemical	Cd, Dioxins, Furans, Hexachlorobenzene, PAHs, PCB, PCP	Cd, PAHs	Cd, PAHs	Cd, PAHs	Cd, PAHs
OSPAR	Cd, Dioxins, DEHP, Furans, PCB,PCP,PAHs	Cd, DEHP, PAHs	Cd, DEHP, PAHs	Cd, DEHP, PAHs	Cd, DEHP, PAHs
Chronic Toxicants, Very Persistent, or Very Bioaccumulative – Process Inputs					
Carcinogens	Cd, Carbon black, EDC, Lead compounds, VCM	1,3-Butadiene, Acrylonitrile, Benzene, Carbon black, Ethylbenzene, Styrene	Carbon black	Carbon black	Carbon black
Mutagens	Cadmium	1,3-Butadiene			
Reproductive / developmental toxicants	Cadmium, Lead compounds	1,3-Butadiene, Benzene			
Endocrine disruptors	Organotins	Styrene			
Very persistent chemicals					
Very bio-accumulative chemicals					

Recyclability Assessment

The ideal end of life options for a product allow it to be: a) reused as the same product (e.g., reusable glass or plastic bottles), b) recycled back into the same product, "closed loop recycling" (e.g., aluminum cans), or c) biodegraded into healthy nutrients for the soil (e.g., organic food). Less preferable than these options -- although more preferable than landfilling or incineration -- is the recycling of a product into a lower value product (e.g., office paper into cardboard boxes): this is called "downcycling." The dominant end of life option for plastic pipes, however, is disposal in either a landfill or incinerator.

This evaluation of the end of life potential for the different plastic pipes is based upon two characteristics:

- current recycling rates and practices, including downcycling, and
- potential recyclability, including integration into a cross industry commodity plan

SF recycling: The current reality of plastic pipe recycling is that the recycling of these products is marginal: very few plastic pipes are recycled in the U.S and most of them are downcycled. In San Francisco, as with most municipalities, plastic pipe is not accepted in residential curbside recycling programs or at drop off centers. Additionally, a survey of firms that recycle construction waste in the Bay Area revealed that most do not accept plastics of any type. Of the firms that do accept plastic building materials, the vast majority only accept HDPE or PP. A smaller number accept ABS, very few accept PVC and none are known to accept PEX[38]. See Table 5 for count of firms in the Bay area that accept the different plastics.

Most efforts to recycle plastic building materials have been thwarted by the daunting problem of creating a secondary material with market value. Establishing an infrastructure to gather, sort, and create a homogenous secondary plastic stream from building materials typically results in a material that costs more than virgin plastic and meets lower performance specifications.

Cross industry efforts: Office furniture maker Herman Miller is exploring solutions to the problem of material recycling in general and plastics recycling in particular by engaging other industry sectors in closing the recycling loop. One concept under exploration is to establish consistent plastic specifications and product labeling, in order to establish a broader commodity market for recycled plastics that could be utilized by manufacturers in different industry sectors. This requires a reversal away from the trend of the last several decades to more designer plastics that are custom tailored to each narrow application. Instead it favors standardization of plastic formulas for use in the widest range of applications[39].

To further understand the potential recyclability of the different pipe plastics and how they are positioned for this type of cross industry commodity recycling effort, the current practices in two other sectors where significant recycling is underway - bottles and automotive part - are assessed.

Bottle recycling: Bottle recycling drives the recycling rates of plastics in the U.S. A recent assessment of the state of plastics bottle recycling by the state of California found that:[40]

- plastics recycling rates continue to lag behind other materials like steel, aluminum, glass, and paper (p.1)
- plastics recycling is largely uneconomical without subsidies (p.1)
- the most recycled plastics nation-wide are PET and HDPE, which account for "more than one-half of national plastics recycling" (p.8)
- other plastics "recycled in significant quantities are polypropylene battery casings; HDPE, LDPE, LLDPE stretch-wrap and film; PET X-ray films; and polystyrene protective packaging" (p.8)

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[38] This analysis is based upon listings as of January 2005 in the Plastics Directory compiled by the San Francisco Department of the Environment. http://temp.sfgov.org/sfenvironment/directories.plastic/htm

[39] Public presentation by Gabe Wing Miller of Herman Miller, Working Towards a Better World, US Green Building Council, Northern California Chapter, San Francisco, CA, January 18, 2005.

[40] California Integrated Waste Management Board, Plastics White Paper: Optimizing Plastics Use, Recycling and Disposal in California (2003) http://www.ciwmb.ca.gov/Publications/default.asp?pubid=1010

- PVC is a contaminant in plastics recycling: "Contaminants such as other resin grades (especially PVC)" and other materials "require extensive sorting and cleaning" (p.15)
- the recycling rate in California in 2001 for PET bottles was 36%, for HDPE bottles it was 38%, for PP bottles it was 7%, and for PVC bottles it was 1% (pp.32-33)

From the California Integrated Waste Management Board's report emerge the following conclusions. First, the municipal recycling infrastructure in the U.S. is primarily oriented to the recycling of HDPE and PET. Second, the secondary plastics recycled in the U.S. are overwhelmingly from the polyolefin plastics of polyethylenes (HDPE, LLDPE, and LDPE) and polypropylene. Third, PVC is a contaminant, not a valued commodity, in the municipal recycling stream. From these conclusions a crude plastics' recycling hierarchy emerges in the U.S., with PET and HDPE the most recyclable plastics, followed by other polyolefins, and with PVC the most undesirable (see Table 5).

Automotive recycling: The state of plastics recycling in the U.S. mirrors current developments in the automotive sector in Europe and Japan. With legislation requiring the take back of vehicles in Japan and the European Union, automakers are evaluating and selecting for plastics that are more recyclable. Pressed to recycle ever greater percentages of end-of-life vehicles, automakers have completed some of the most extensive assessments on the recyclability of plastic materials.

For example, in 2001, Opel (a European division of General Motors) published its plastics recyclability hierarchy in its environmental report (see Table 4 below). The preferred plastics for recycling were the polyolefins (PP and PE) and the least preferred plastics were a "mixture of incompatible materials" and "PVC."

	Table 4. Opel Priority List for Plastics with Regard to Recycling Aspects[41]
Prefer	**Polypropylene (PP), Polyethylene (PE)**
	Polyoxymethylene (POM), Polyamide, Thermoplastic Urethane (TPU)
	Acrylonitrile Butadiene Styrene (ABS), Polymethylmethacrylate (PMMA, i.e., acrylic), Styrene Maleic Anhydride (SMA) copolymer, Acrylonitrile Styrene Acrylate (ASA), Styrene Acrylonitrile (SAN)
	Polycarbonate, Polyethylene Terephthalate (PET), Polybutylene Terephthalate (PBT)
	Thermoplastic Elastomer (TPE)
	Polyurethane
	Sheet Molding Compound (SMC), Phenol-Formaldehyde (PF)
	Elastomer
	Polyvinyl Chloride (PVC)
	Mixture of incompatible materials

Increasing preference →

Opel is not alone in its assessment of plastics. Honda, Nissan, and Toyota have all identified polyolefins as the preferred plastics from the perspective of recyclability. Honda, for example, states in its 2003 Environmental Annual Report that it is standardizing for polyolefin resins: "For all of the new models and changed models released in fiscal 2002, highly recyclable olefin resins are now used for injection-molded interior parts"; including trunk decoration, instrument panels, bumper faces, air conditioning units, and door linings.[42] Polypropylene bumpers are now widely recycled in Japan. Nissan, for example, collected 231,576 polypropylene bumpers in 2002 for use as used bumpers (as replacement parts) and with the goal of using the recycled bumpers on new models.[43] Regarding PVC, Toyota in its 2003 Environmental and Social Report stated that it "is actively engaged in reducing the volume of PVC resin used."[44]

[41] Opel. 2001. *Environmental Report 2000/2001.*
[42] Honda. 2003. *Environmental Annual Report 2003*, p.32.
[43] Nissan, 2003. *Environmental and Social Report (year ended March 31, 2003*, pp.32+38.
[44] Toyota. 2003. *Environmental & Social Report 2003*, p.37.

PEX is not referenced in these reports due to its low usage in these sectors. PEX recycling is hampered by the crosslinking of the molecules. Cross-linked plastics like PEX are known as "thermoset" plastics. A thermoset plastic is hardened by curing, creating a three-dimensional, inter-connected structure that cannot be re-melted or re-molded; it is infusible and insoluble.[45] This makes thermosets like PEX very difficult to recycle. The only current recycling option for PEX is to grind it down and use as filler in another material.

Table 5 summarizes the data collected on the recycling and recyclability of the plastics used in pipes. The polyolefins -- especially HDPE (municipal bottle recycling) and PP (automotive sector) -- are the preferred pipe plastics used in for municipal and automotive recycling programs and with the most acceptance by regional plastic recyclers in the Bay area. ABS is recyclable, but receives little attention in these assessments of plastics recycling because of its smaller levels of production relative to HDPE, PP, and PVC. PEX receives little attention because it is both a relatively small volume plastic and inherently very difficult to recycle.

PVC is a plastic that municipal and automotive recycling programs are actively avoiding. The array of toxic additives included in PVC (as discussed in the previous life cycle section) as well as it being a contaminant in municipal recycling, make it a largely unwanted post-consumer material. While manufacturers of PVC -- especially in Europe -- are trying to develop a post-consumer recycling market for PVC, their initiative is receiving a lukewarm response from the users of plastics, as exemplified by the automotive sector's decision to de-select PVC.

Table 5. Assessment of Recyclability of Plastics Used in Pipes

	Avoid		Concern	Prefer	
	PVC	**PEX**	**ABS**	**PP**	**HDPE**
Summary assessment	Little recycling. Considered a contaminant to municipal recycling	Very limited recycling, only recycled as filler in other products, not recycled back into pipe	Recyclable but small markets	Established post consumer recycling markets (automotive)	Established post consumer recycling markets (bottles)
SF area recycling outlets	5 companies accept drop off	None known in bay area	7 companies accept drop off, many w/minimum amts	11 companies accept drop off	13 companies accept drop off
Municipal bottle recycling	Contaminant in bottle recycling streams	Not applicable, no use in this sector	Not applicable - recyclable but little use in this market	Marginal levels of recycling	Highly recyclable, well established markets
Automotive recycling	Among the least preferred plastics	*No data on PEX use and recycling in this sector*	Recyclable, moderately preferred, but used in low volumes	Highly recyclable, established markets, most preferred	Highly recyclable, established markets, most preferred

[45] Stevens, 2002, p.39. HDPE, PP, ABS, and PVC are all "thermoplastics." Since thermoplastics can be repeatedly softened and hardened by heating and cooling, they are much easier to recycle than thermosets.

Summary of Environmental Preferability Analysis

The hazards and recyclability assessments clearly indicate that PVC is environmentally less preferable than HDPE and PP. ABS and PEX occupy a middle ground between the poles of PVC -- to be avoided -- and HDPE and PP -- to be preferred (see Table 6). ABS is in the middle ground because of its better recycling profile than PVC. For PEX, while it is preferable to ABS and PVC on hazards, questions remain about its recyclability.

- ABS and PVC have more significant Chemicals of Highest Concern across their life cycles than HDPE, PP, and PEX,
    - PVC is of somewhat greater concern than ABS because of its linkage with chemicals targeted for elimination by international treaty: the Stockholm Convention on POPs
- PVC has a negative recycling profile: it is considered a contaminant in municipal recycling programs.
- ABS and PEX have limited to no recyclability data.
- HDPE through packaging and PP through the automotive sector both have established post-consumer recycling markets.

There are no rating differences between HDPE, PEX and PP in the hazards assessment portion of this analysis. PEX ranks below HDPE and PEX due to its lack of recyclability Therefore HDPE and PP share the highest relative environmental preferability ranking in this assessment, followed by PEX. It is important to keep in mind when reading this analysis that all of these plastics have significant toxicity problems and much of the recycling is still downcycling. There remains much work to be done to find truly environmentally healthy plastics for these applications.

Table 6. Combined Preferability of Pipes based on Hazard and Recycling Assessments

	Avoid	Concern		Prefer	
	PVC	**ABS**	**PEX**	**PP**	**HDPE**
Summary chemical hazard assessment	·EPA PBT & ·EPA/OSPAR Priority outputs plus ·Stockholm/OSPAR outputs & ·EPA/OSPAR Priority inputs & additional chronic toxicant inputs	·EPA PBT & ·EPA/OSPAR Priority outputs plus additional ·Chronic toxicant inputs	·Significant EPA PBT & EPA/OSPAR Priority outputs	·Significant EPA PBT & EPA/OSPAR Priority outputs	·Significant EPA PBT & EPA/OSPAR Priority outputs
Summary recycling markets and recyclability assessment	·Not recyclable ·Considered a contaminant to municipal recycling	·Recyclable but small markets	·Very limited ·Only recycled as filler in other products. Can never be closed loop recycled	·Established post consumer recycling markets (automotive)	·Established post consumer recycling markets (bottles)

Remember that all of these plastics have significant toxicity problems and much of the recycling is still downcycling. There remains much work to be done to find truly environmentally healthy plastics for these applications.

Performance Evaluation

The final step of this analysis evaluates the performance characteristics for each pipe plastic in different applications. Performance of the different pipe plastics are evaluated for the following applications:

- Water Distribution
- Drain Waste and Vent (DWV)
- Sanitary Sewer
- Storm Sewer
- Irrigation and Drainage

The discussion of characteristics is qualitative where a specific rating measure is not listed. Performance characteristics will be compared across pipe plastics and for their impact on the usefulness of the pipe plastic for each of the applicable applications.

Polyvinyl Chloride (PVC) provides a good combination of long-term strength and high stiffness. PVC has good chemical resistance to a wide range of corrosive fluids, but may be damaged by ketones, aromatic and some chlorinated hydrocarbons. It is used in DWV, storm, sanitary, and water distribution applications.[46] PVC pipe is primarily joined by either by bell and spigot or by chemical solvent cementing - which has additional toxicity problems not addressed in this report.

Acrylonitrile-Butadiene-Styrene (ABS) is formed from three distinct monomer building blocks. Substances of these types are usually referred to as copolymers. The proportions of each substance will determine the physical properties of the final product. In this case, acrylonitrile contributes rigidity, strength, hardness, and chemical and heat resistance. Butadiene contributes impact resistance. Styrene increases the ease of processing. ABS is primarily used for DWV applications. ABS pipe can be joined by solvent welding or threading.[47]

High Density Polyethylene (HDPE) exhibits good chemical resistance, flexibility (without the addition of plasticizers) and abrasion resistance. It can be used for pressure and non-pressure applications and is increasingly available with higher pressure ratings. HDPE retains its strength and flexibility even at subfreezing temperatures. Its inherent flexibility provides better resistance to ground movement, earthquakes, and damage during installation or intrusion during excavations. The flexibility of HDPE has also made it increasingly popular in some parts of the country (including the San Francisco area) for trenchless sewer replacement, providing significant savings in trenching costs and environmental impact. Coiling is possible with small diameter polyethylene pipe which makes it useful for gas distribution and water services. In some applications flexible HDPE pipe can provide cost savings by minimizing and eliminating the need for jointing. The pipe can be bent around corners and around physical obstructions.

The principle joining method is heat fusion, where pipe ends are thermally butt-fused together. This can make a virtually leak-proof joint stronger than the pipe itself and considered by some to be superior to the solvent welds or threaded joints of PVC and ABS. HDPE may also be joined by other methods such as compression fittings.

The primary HDPE applications are: irrigation and drainage, water and storm and sanitary applications[48].

Cross Linked Polyethylene (PEX) is made up of polyethylene molecules that are cross linked in order to raise the maximum operating temperature up to 200 ^{0}F (93 ^{0}C). Other performance characteristics are similar to HDPE. Common applications are primarily inside buildings, including under-floor hydronic heating systems, and hot-cold water systems. PEX pipe is primarily available in small sizes appropriate to these applications. Connections are primarily made with compression fittings.

Polypropylene (PP) shares similar properties with polyethylene and generally has better chemical resistance than other plastics. PP is used in some pressure piping applications, but its primary use is in low pressure lines. Polypropylene plastic pipe is used for chemical (usually acid) waste drainage systems, sanitary and water lines, though almost exclusively outside of North America. In 2004, however, a

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[46] CBD-220. Thermoplastic Pipe, National Research Council of Canada, Institute for Research in Construction http://irc.nrc-cnrc.gc.ca/cbd/cbd220e.html
[47] CBD-220
[48] CBD-220

German firm, Aquatherm, began marketing PP in North America for potable-water, hydronic-heating, and other pressurized piping applications[49]. Another manufacturer intends to introduce a PP sanitary line in 2005[50]. Pipe lengths are joined by heat fusion, threading (i.e., with heavy pipe) and mechanical seal devices.[51]

Pipe Sectors

Within each sector, design, construction and operational and maintenance considerations impact plastic selection. As these sectors differ from one another, it is important to recognize that one plastic may not be appropriate for use over all sectors.

Water Distribution

Water distribution systems are defined as those that convey potable water, typically from water treatment facilities, to the end user. These systems are a tree-like pipe network consisting of:

- Transmission lines - (water mains - typically 36" diameter or less)
- Distribution lines - (lower diameter sizes: 6" - 12")
- Service connections - (from street to building)

Water mains typically operate at pressures from 100 to 150 lbs per sq. in. (psi), while distribution lines operate between 40 and 100 psi[52].

The primary plastics used for water distribution in North America are HDPE and PVC. HDPE pipe performs roughly equivalently to PVC in water main applications, with similar corrosion resistance and durability. HDPE has a slight advantage in terms of preventing leaks as the butt-fusion method used to join HDPE provides stronger, tighter, more leak proof joints compared to the bell and spigot joints used in PVC pipe[53]. PEX is also used in this application, primarily for small diameter distribution applications within buildings. PEX is generally not used for the other applications surveyed here.

Drain, Waste and Vent (DWV)

DWV is essentially the sanitary sewer system before it leaves the property line. PP, PVC, HDPE and ABS are all in use in DWV applications domestically and/or in foreign markets. Because of the wide range of labor, fire and other code issues, selection of DWV can be challenging in North America and one or more of these alternatives has been restricted for DWV use in the USA. For example, New York State labor code prohibits the use of PVC pipe in buildings greater than three stories. Fire codes may prohibit the interior use of HDPE in some states. A full analysis of code restrictions on pipe alternatives in DWV is beyond the scope of this report.

Sanitary Sewer

Sanitary sewers collect waste water from homes and business and convey it for treatment. Sanitary sewer collection systems, like water distribution systems, are a tree-like pipe network and consist of:

- Interceptor Sewers – (carry wastewater from collecting sewers to the wastewater treatment facility. From 15" up to several feet in diameter)
- Collecting Sewers – (collect from service connections with typical diameters of 6" to 12")
- Service connections - (from street to building).

Sanitary sewers release corrosive gases. Because of the resistance to corrosion provided by the plastics, they are increasingly preferred to non-plastic alternatives for sanitary applications. Currently, PVC is the most widely used plastic for sanitary sewer in North America but HDPE is gaining market share in some areas, including the San Francisco area, particularly for its ability to be used for trenchless sewer replacement (not possible with PVC). HDPE also has a slight advantage in chemical and abrasion

[49] Environmental Building News, "Fusiotherm Polypropylene Piping From Aquatherm", September 2004 Volume 13, Number 9
[50] Personal communication with Jamie Harvie.
[51] CBD-220 NRC
[52] Environment Canada, "A Technical and Socio-Economic Comparison of Options to Products Derived From the Chlor-alkali Industry" 1999
[53] Environment Canada

resistance. On the other hand, gravity lines, such as sewer and drainage require close attention to proper installation gradient to ensure proper flow, whereas pressure lines which do not require this gradient, offer greater leeway. As a result, gravity line pipe is typically installed in sections which allow closer installation and monitoring, which is more difficult with the use of long, more flexible, continuously welded pipe. This has made HDPE more popular for trenchless replacement slip lining than for new sanitary gravity pipe lays, but not exclusively. Hancor, a US pipe manufacturer has just introduced a HDPE pipe, which comes in 20 foot sections and intended for sanitary applications. Available in larger diameters, the pipe is joined through fusion welding.

In Europe, more rigid PP is gaining in popularity. Though it has not yet been marketed for this application in the US, a European manufacturer plans to market a PP pipe for sanitary applications in the US market[54].

Storm Sewer

Prior to the 1960s most sewer systems were combined sewers, that is, carried both sanitary and storm water. The system had to be designed to carry large volumes of water during rain events, but otherwise the capacity was little used. In addition, when it did rain the flood of relatively fresh water often negatively impacted water treatment. Design changed so that by the mid 1960s sanitary and storm systems were designed and constructed separately. Storm sewers collect water from roof drains, parking lots and streets. Unlike sanitary sewers, storm wastewater is not typically treated and the flow is directly discharged into a receiving body of water. PVC and HDPE are the plastics most widely used in North America. Since storm sewers are also a non pressurized, gravity flow application, the performance concerns are similar to sanitary sewer applications, with the notable exception that corrosive gas resistance is less important.

Irrigation and Drainage

PVC, PP and HDPE are all used for irrigation water distribution in the US with similar performance characteristics. Because the distributed water is under pressure, leakage performance is again significant. PVC has dominated irrigation applications in recent years, but HDPE is now beginning to regain share due in part to the labor savings of layout from long coils with fewer joints versus the short rigid sections of PVC and its higher resistance to shovel damage and joint failure.

Plastic pipes, both PVC and HDPE, are gaining rapidly in the huge drainage market previously dominated by concrete and steel. Recently, the Corrugated Polyethylene Pipe Association initiated a third party certification system which allows for increased acceptance of their product by the American Association of State Highway and Transportation Officials. High recycled content HDPE is now available on the market for this application. Performance issues are similar to storm sewer applications.

Duct and Conduit

PVC and HDPE are both used for electrical duct and conduit. Rigid PVC can have an advantage in requiring fewer hangars in suspended applications. Flexible HDPE can have the advantage in easier installation for long continuous runs and bends without requiring joints. HDPE also has a lower coefficient of friction thus making cable fishing and pulling easier. Fire resistant HDPE is available. PP is also used where higher temperature resistance is required, but not widely available in North America.

Cost Issues

All pipe sectors have at least one viable plastic alternative, with the exception in North America of DWV, where there is still limited access to polyolefin based plastic pipes, although Aquatherm's market introduction may change this soon. The issue of cost differential is extremely complex. Conversation with industry officials and literature review suggest that pipe material cost differences, if they do exist, are not the determinant issue in pipe selection[55]. Pipe project costs are highly dependent on a number of important variables which include but are not limited to: market location and its proximity to

[54] Personal communication with Jamie Harvie.

[55] For more discussion on this topic see Harvie, Jamie etal, "PVC-Free Pipe Purchasers' Report", Healthy Building Network 2002, http://www.healthybuilding.net/pvc/pipes_report.html

manufacturing, material/resin costs which can vary rapidly over time, soil and other site conditions, local labor costs, contractor experience with the pipe type, and installation method. While it is difficult to make across the board statements about the cost implications of plastic selection, a recent report found that less toxic alternatives are successfully competing with PVC in many pipe applications.[56]

Lifespan and Durability

There is much debate over the durability and expected lifespan of plastic pipes. The long term durability of piping systems depends on many factors, including the soil environment, proper installation, material properties such as corrosion resistance, chemical resistance and strength and the performance of joints[57]. Because of the characteristics of storm and sanitary flow, conveyance systems must offer good resistance to corrosion, chemicals and abrasion. All plastics under consideration offer good resistance to these forms of degradation. All of the plastics have been on the market for decades[58]. When properly designed and installed, pipe systems of any of these materials can be sufficiently durable to withstand many decades of services[59].

Summary of Performance Evaluation

Table 7 compares the relative performance and availability of the various plastics by application. ABS and PEX have characteristics that lead them to be used primarily in a limited number of applications. PVC, HDPE and PP meanwhile are competitive in most applications with many similar performance characteristics and modest tradeoffs in others. The net result is that plastic alternatives exist in the Prefer category (HDPE and PP) for each of the pipe applications studied that perform equal to or better than the plastics in the Concern or Avoid categories.

Market availability

While regional availability may vary, only the market availability of alternatives for DWV is significantly limited across North America, due in part to state and local building code challenges and part due to manufacturer market decisions. Differences in market share across the applications are primarily a function of the historical marketing focus of the manufacturers rather than of purchaser selection. For example, PVC manufacturers pursued municipal markets before HDPE; hence they have the dominant market share in municipal markets. Meanwhile, HDPE manufacturers targeted industrial markets where HDPE's corrosion resistance created performance advantages.

Access to alternative plastics is growing as manufacturers are increasingly targeting new markets across these traditional boundaries. European PP manufacturers are beginning to enter into the North American market and North American HDPE manufacturers are expanding their offerings to cover more applications. Even in the constrained North American DWV market, options are beginning to emerge. Forward looking environmentally preferable purchasing policies by corporate and government entities can aid this market transformation. There is no reason not to move forward in selection of more preferable alternative pipe plastics.

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[56] Ackerman, Frank, etal "The Economics of Phasing Out PVC", Tufts University, 2003 http://www.healthybuilding.net/pvc/Economics_Of_Phasing_Out_PVC.pdf
[57] Environment Canada
[58] PEX has only been in the North American market since 1995 but has been used widely in Europe for decades. Likewise PP has had relatively limited marketing in North America but has been widely used in Europe for decades.
[59] Environment Canada

Table 7. Application Specific Performance & Availability Comparison for Plastic Pipes

	PVC	ABS	PEX	PP	HDPE
- Water distribution	Good/Good	Not used/NA	Good/ Good[x]	Good/Poor[†]	Good/Good[o]
- Drain/Waste/Vent	Good/Good	Good/Good	Not used/NA	Good/Poor[†]	Not used/NA
- Sanitary sewer	Good/Good	Not used/NA	Not used/NA	Good/Poor[†]	Good/Good
- Storm sewer	Good/Good	Not used/NA	Not used/NA	Good/None*	Good/Good
- Irrigation & drainage	Good/Good	Not used/NA	Not used/NA	Good/None*	Good/Good
- Duct & Conduit	Good/Good	Not used/NA	Not used/NA	Good/Poor*	Good/Good

First item before the "/" is the general performance assessment. The item after the "/" is the market availability assessment..
Not used means not typically specified or used in these applications. NA means market availability is not applicable as there is no demand because the plastic type is not typically used

[x] Used only in small diameter pipes, primarily for water distribution and radiant systems in buildings.

[o] Used primarily in large diameter piping outside the building

[†] Available in Europe, in early stages of marketing in US in 2005

* Available in Europe, not yet marketed in the US

See Appendix 7 for more detailed charts of plastic pipe performance by application

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Conclusion

This study seeks to answer the question of whether there are significant differences between the plastics used to manufacture pipes with a focus on priority environmental health impacts and end of life recyclability. No determination is made on whether plastics are either more or less preferable to the traditional materials used to manufacture pipes. Rather the evaluation is for decision-makers interested in understanding the environmental differences between plastics.

In this report, the plastics used to manufacture pipes are analyzed and compared for chemical hazards, recyclability and performance. The chemical hazard and recyclability assessments evaluate the environmental sustainability of plastics, while the performance assessment gauges the technical, market, and economic viability of the materials in different applications.

Table 8 summarizes the results of the analysis and the conclusions of this report.

The analysis of the existing data leads to four primary conclusions:

- HDPE and PP are the most environmentally preferable plastics currently used to manufacture pipes under this chemical hazard and recyclability based analysis with no significant distinction between them. Yet even these plastics have their environmental downsides.
- HDPE, PP, and PEX create less chemical hazards of high concern across their life cycles than ABS and PVC.
- HDPE and PP are the most recyclable of the materials. There is less of a market for recycling ABS. PEX is not truly closed loop recyclable, and while PVC is marginally recyclable under some circumstances it is considered a contaminant in many recycling programs and increasingly avoided in some sectors.
- Plastic pipe alternatives exist in the Prefer category in this analysis (HDPE and PP) that perform equal to or better than the plastics in the Avoid and Concern categories (PVC, ABS and PEX) for each of the pipe applications studied. Availability of preferable alternatives is good in North American markets with the exception of drain-waste-vent (DWV) applications. The entry of new PP and HDPE products, with encouragement from environmentally preferable purchasing policies, is expected to expand availability of preferable alternative options in the North American market for all applications including DWV.

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Table 8. Summary of Plastic Pipe Environmental Preferability Analysis

	Avoid	Concern		Prefer		
	PVC	**ABS**	**PEX**	**PP**	**HDPE**	**Preferable**
Summary of chemical hazard & recyclability assessments	[redacted]	·more chemical hazard ·low recycling	·less chemical hazard ·very limited recyclability	·less chemical hazard ·good recyclability	·less chemical hazard ·good recyclability	Truly preferable plastic pipes do not yet exist
--- Chemical Hazard Assessment ---------						
Stockholm POPs (outputs after refining)	[redacted]	+ none	+ none	+ none	+ none	
OSPAR & USEPA PBT & Priority Chemical (inputs)	[redacted]	+ none	+ none	+ none	+ none	
Chronic toxicants; Carcinogens, mutagens, developmental or reproductive toxicants or endocrine disruptor (inputs)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Other PBT Outputs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
--- Recyclability Assessment--------						
Summary recycling markets and recyclability assessment	[redacted]	Recyclable but small markets	[redacted]	+ Established post consumer recycling markets (automotive)	+ Established post consumer recycling markets (bottles)	-
--- Performance / Availability Assessment--------						
- Water distribution	Good/Good	Not used/NA	Good/Good*	Good/Poor*	Good/Good*	
- Drain/Waste/Vent	Good/Good	Good/Good	Not used/NA	Good/Poor	Not used/NA	
- Sanitary sewer	Good/Good	Not used/NA	Not used/NA	Good/Poor	Good/Good	
- Storm sewer	Good/Good	Not used/NA	Not used/NA	Good/None	Good/Good	
- Irrigation & drainage	Good/Good	Not used/NA	Not used/NA	Good/None	Good/Good	

*PEX is used only in small diameter piping primarily for water distribution and radiant systems in buildings. HDPE for water distribution is used primarily in larger diameter piping outside the building. PP is just beginning to be marketed in North America

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Appendix 1 - Principles of Decision Making: Life Cycle, Precaution & Pollution Prevention

The screening based method described in this report to evaluate the plastics used in pipes is founded upon three principles:

1) Life Cycle Thinking:

In life cycle thinking the stages of a material's life -- beginning with raw material extraction and ending with disposal (or reuse/recycling/composting) -- provide the frame for evaluating the presence of toxic inputs and toxic outputs. Life cycle thinking, as Todd and Curran (1999) emphasize, is "a unique way [relative to quantitative life cycle assessment (LCA)] of addressing environmental problems from a systems or holistic perspective" because it challenges the "need for a complete inventory of material and energy flows associated with the system of interest."[60] In fact, it challenges not only the need, but also the attainability and the practical usefulness of quantitative LCA in establishing materials policies such as this.

The method used here to evaluate plastic pipes does not attempt to quantify total outputs of toxic chemicals nor normalize results to a functional unit, but rather bases judgments upon screening simply for direct existence or nonexistence of target outputs.

Quantified risk analysis type approaches such as applied by most LCA tools are severely limited in their usefulness for policy judgments for a variety of reasons. Efforts to quantify impacts as they relate to human and ecological toxicity have run up against a number of significant barriers:

- Toxic chemical release data are a poor indicator of potential impacts because there is no simple linear relationship between measured releases and impacts:
    - Some chemicals persist in the environment, bioaccumulate in organisms, and biomagnify up the food chain. The result is that a given amount of release will result in widely different and not readily predictable exposures to different populations dependent upon factors like geography and location on the food chain.
    - Furthermore, many of these same chemicals are toxic at very low doses. Thus small releases of these chemicals – sometimes at levels well below thresholds that are easily monitored for quantification are of high concern. That is, any release – even a very small one - can result in significant exposures in humans and wildlife.
    - Adverse effects may be more a factor of the timing of the exposure -- e.g., the developing fetus exposed to phthalates -- rather than the dose of the exposure.
    - Individuals are exposed to a complex soup of chemicals - many that can cause the same adverse effects and some that are synergistic - rather than only to a single chemical at a time. Thus the cumulative doses of exposure to potential impacts are greater than assumed for any individual chemical. Additional exposures to a single chemical may have threshold or synergistic effects far beyond those predicted by one at a time controlled studies would indicate.

- LCA models suffer from a great paucity of comprehensive and reliably comparable data:
    - Release data is primarily based upon stack and pipe release estimates. Exposures that occur in the workplace, from the use of products, and from food are not included, although they are critically important additive factors to the impact.
    - Release data based upon the Toxics Release Inventory (TRI) database isn't even complete for stack and pipe releases as reporting requirements do not apply to all releasers.
    - Most LCA models are very limited in which datasets are incorporated and may be missing significant portions of life cycle releases.
    - Data are often of widely varying quality across materials and rarely transparent to the user for quality checking.

[60] Todd, Joel Ann and Mary Ann Curran (eds.), 1999, *Streamlined Life-Cycle Assessment: A Final Report from the SETAC North America Streamlined LCA Workgroup* (Pensacola: SETAC).

- The sheer volume of data inputs makes thorough quality checking impossible.
- The large number of assumptions with high variability and uncertainty generally leads to a high uncertainty in the absolute metric that is rarely reflected in the results of LCAs despite the fact that these uncertainties can be much larger than the differences reflected in the LCA result.
- Many simplifying assumptions and interpretive algorithms are needed to translate data into common metrics, compare different impact types and pathways and manage the different data sources. These each contain significant assumptions that are seldom transparent to the user.61

- The need to reduce everything to a common metric for LCAs requires reducing every human health impact -- including carcinogenicity, mutagenicity, and reproductive, developmental, and neurological toxicity to a relative quantitative value, masking core values.

LCAs have a place in narrowly defined industrial analysis for single manufacturers, where the data set is closely held and the set of parameters to capture is constrained, but for broader materials policy work like this it is sorely lacking. The task of quantification demanded by LCAs, is laborious, masks critical values and ultimately at this scale may be of questionable scientific validity.

The method used here based upon life cycle thinking instead uses a more straightforward knock-out screens for the most toxic chemicals of concern. That is, it sets screens for materials based simply upon use of these chemicals or the creation of them as byproducts instead of attempting to compare quantities and scale to assumed impacts.

2) Pollution Prevention:

Reducing toxicants before they are used or generated as byproduct has priority over controlling toxics at the end-of-the-pipe. The primacy of prevention is established in the Pollution Prevention Act of 1990:

> The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

When developing a method where prevention has primacy over control, it places the emphasis of the analysis on evaluating whether a toxic chemical is present or absent in the life cycle of a material (just s the life cycle thinking approach does) -- as either an input or output in each stage of the material's life cycle -- rather than quantifying the amount of the chemical released into the environment for each stage. It is a binary system. Toxic chemicals are either present or not present. A binary system is particularly appropriate when dealing with PBTs, inasmuch as even low level releases can result in significant adverse public and environmental impacts. For example, the International Joint Commission (IJC) concluded in its *Sixth Biennial Report on Great Lakes Water Quality* that "we should immediately begin a process to eliminate" PBTs because "it seems impossible to eliminate discharges of these chemicals through other means." Therefore, continued the IJC, "a policy of banning or sunsetting their manufacture, distribution, storage, use and disposal appears to be the only alternative."[62]

The hierarchy of materials management established in the Pollution Prevention Act also emphasizes the importance of recycling materials before disposing of them. Therefore the method should include an assessment of whether materials are recycled, as well as the impacts that may occur from recycling.

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[61] See *Environmental Building News*, March 2002, "Life-Cycle Assessment for Buildings: Seeking the Holy Grail," Vol. 11, No. 3.

[62] International Joint Commission (IJC), 1992, *Sixth Biennial Report on Great Lakes Water Quality* (Washington, DC: IJC).

3) Precautionary Principle:

Precautionary approach to decision making is especially relevant to the proposed method:

San Francisco's Precautionary Principle Ordinance, passed in 2003, states that it is the responsibility of government agencies to take action to protect human health and the environment in the face of scientific uncertainty[63]. Traditionally governments ask, "How much environmental harm will be allowed?" in San Francisco, decision-makers ask a very different question: "How little harm is possible?"

Taking action on early warnings is incorporated into the screening method by selecting criteria that reflect the presence of materials known to be of concern due to their toxicity, persistence, and bioaccumulative properties. Historically, environmentally harmful activities have only been stopped after they have manifested extreme environmental degradation or exposed people to harm. In the case of PCBs, DDT, lead, and asbestos, for instance, regulatory action took place only after disaster had struck.

Seeking the safer alternatives is a central element of the precautionary approach and involves the careful assessment of available alternatives using the best available science[64]. An alternatives assessment examines a broad range of options in order to present the public with the consequences of each approach. The process takes short-term versus long-term effects or costs into consideration, and evaluates and compares the adverse or potentially adverse effects of each option, giving preference to those options with fewer potential hazards. The screening process used in this plastic pipe assessment presents decision makers with answers to these fundamental questions: "Is this potentially hazardous product necessary?" "What less hazardous options are available?" and "How little damage is possible?"

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[63] San Francisco Precautionary Principle Ordinance, Chapter 1 of Environment Code: www.sfenvironment.org
[64] Lowell Statement on Science and the Precautionary Principle (2001).

Appendix 2 - Chemicals Targeted for Elimination / Reduction by the Stockholm Convention, US EPA and OSPAR

CHEMICALS	Stockholm POPs[65]	US EPA PBTs[66]	OSPAR Priority Chemicals[67]	US EPA Priority Chemicals[68]
1,2,4,5-Tetrachlorobenzene				X
1,2,3-trichlorobenzene			X	
1,2,4-trichlorobenzene			X	X
1,3,5-trichlorobenzene			X	
2,4,5-Trichlorophenol				X
2,4,6-tri-tert-butylphenol (phenol)			X	
4-(dimethylbutylamino) diphenylamin (organic nitrogen compound)			X	
4-tert-butyltoluene (aromatic hydrocarbon)			X	
4-Bromophenyl phenyl ether				X
Acenaphthene				X
Acenaphthylene				X
Anthracene				X
Aldrin	**X**	**X**		
Benzo(a)pyrene		**X**		
Benzo(g,h,i)perlyene				X
Brominated flame retardants (BFRs), incl. tetrabromobisphenol A (TBBPA)			X	
Cadmium and compounds			**X**	**X**
Chlordane	X	X		
clotrimazole (pharmaceutical)			X	
DDT	**X**	**X**		
dicofol (pesticide/biocide)			X	
Dieldrin	X	X		
Endosulfan (pesticide/biocide)			X	X
Endrin	X			
Fluorene				X
Heptachlor	X			X
Hexachlorobenzene	**X**	**X**		**X**
Hexachlorobutadiene				X
Hexachlorocyclohexane isomers (HCH) (pesticide/biocide)			X	X
Hexachloroethane				X
Hexachlorocyclopentadiene (HCCP)			X	
Hexamethyldisiloxane (HMDS) (organosilicane)			X	
Lead and organic lead compounds		**X**	**X**	**X**

[65] The text of the Stockholm Convention can be found at: http://www.pops.int/documents/convtext/convtext_en.pdf
[66] The list of priority PBT chemicals for which the USEPA is developing national action plans can be found at: http://www.epa.gov/opptintr/pbt/
[67] The list of chemicals identified by the OSPAR Commission for priority action can be found at: http://www.ospar.org/eng/html/
[68] The USEPA NPEP list can be found at: http://www.epa.gov/epaoswer/hazwaste/minimize/chemlist.htm

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Appendix 2 (continued) - Chemicals Targeted for Elimination / Reduction by the Stockholm Convention, US EPA and OSPAR				
Mercury and organic mercury compounds		**X**	**X**	**X**
Methoxychlor (pesticide/biocide)			X	X
Mirex	X	X		
Musk xylene			X	
Naphthalene				X
Neodecanoic acid, ethenyl ester (organic ester)			X	
Nonylphenol/ ethoxylates (NP/NPEs) and related substances (phenol)			X	
Octachlorostyrene (OCS)		X		
octylphenol (phenol)			X	
organic tin compounds			**X**	
Pendimthalin				X
Pentachlorobenzene				X
Pentachloronitrobenzene				X
Pentachlorophenol (PCP) (pesticide/biocide)			**X**	**X**
Perfluorooctanyl sulphonic acid and its salts (PFOS)			X	
Phenanthrene				X
Phthalates: Dibutyl phthalate (DBP), diethylhexyl phthalate (DEHP)			**X**	
Polyaromatic hydrocarbons (PAHs)			**X**	**X**
Polychlorinated biphenyls (PCBs)	**X**	**X**	**X**	**X**
Polychlorinated dibenzodioxins (PCDDs)	**X**	**X**	**X**	**X**
Polychlorinated dibenzofurans (PCDFs)	**X**	**X**	**X**	**X**
Pyrene				X
Short chained chlorinated paraffins (SCCP)			X	
Toxaphene	X	X		
Trifluralin (pesticide/biocide)			X	X
Triphenyl phosphine (organophosphate)			X	
Total # of Chemicals Listed	**12**	**14**	**32**	**31**

Bold rows are chemicals that are evaluated in pipes in this assessment

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Appendix 3 - Priority Chemicals of Highest Concern in Outputs

Lifecycle Stages	Stockholm Convention POPs				US EPA PBTs				OSPAR + US EPA Priority Chemicals			
	PVC	ABS	HDPE & PEX	PP	PVC	ABS	HDPE & PEX	PP	PVC	ABS	HDPE & PEX	PP
--- Initial raw material extraction and processing --------												
Brine extraction	No data	na			No data	na			No data	na		
Natural gas / oil extraction	Water effluent: furans				Water effluent: furans, lead and mercury				Water effluent: cadmium, DEHP, furans, lead, mercury, PAHs, pentachlorophenol			
Natural gas processing	none				none				none			
Crude oil refining	Air emissions: dioxins*; Water effluent, raw: aldrin, DDT				Air emissions: dioxins, benzo(a)pyrene; Water effluent, treated: benzo(a)pyrene, lead, mercury; Water effluent, raw: aldrin, DDT				Air emissions: dioxins; Water effluent, treated: cadmium, DBP, PAHs, pentachlorophenol			
Chlorine production	Byproducts: furans, PCBs, hexachlorobenzene	na			Mercury**; Water effluent, treated: lead, Octachlorostyrene	na			Mercury; Water effluent, treated: lead; Water effluent, untreated: cadmium	na		
na = not applicable * from petroleum refining catalyst regeneration ** from the mercury cell diaphragm process												
--- Feedstock, Resin, Polymer, and Product Production ------												
Acrylonitrile production	na	No data	na		na	No data	na		na	No data	na	
Benzene production	na	none	na		na	Water effluent, treated: benzo(a)pyrene, lead, mercury	na		na	Water effluent, treated: cadmium, DEHP, lead, mercury, PAHs	na	
1,3 butadiene	na	No data	na		na	No data	na		na	No data	na	

na = not applicable to this plastic Blank cells = no data collected for this topic

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Appendix 3 - Priority Chemicals of Highest Concern in Outputs (continued – 2 of 3)

Lifecycle Stages	Stockholm Convention POPs				US EPA PBTs				OSPAR + US EPA Priority Chemicals			
	PVC	ABS	HDPE & PEX	PP	PVC	ABS	HDPE & PEX	PP	PVC	ABS	HDPE & PEX	PP
--- Feedstock, Resin, Polymer, and Product Production (cont) --------												
Styrene Production	na	none	na		na	Water effluent, treated: benzo(a)pyrene	na		na	Water effluent, treated: PAHs	na	
Ethylene production	none			na	Water effluent, treated: benzo(a)pyrene, mercury			na	Water effluent, treated: DEHP, mercury, PAHs, cadmium			na
Propylene production	na			none	na			Water effluent, treated: benzo(a) pyrene, mercury	na			Water effluent, treated: DEHP, mercury, PAHs, cadmium
Ethylene dichloride (EDC) and vinyl chloride monomer (VCM) production	Byproduct: dioxins, furans, PCBs, hexachlorobenzene	na			Byproduct: dioxins, furans, PCBs	na			Byproduct: dioxins, furans, PCBs, hexa-chlorobenzene; Water effluent, treated: DEHP, DBP, penta-chlorophenol	na		

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Appendix 3 - Priority Chemicals of Highest Concern in Outputs (continued - 3 of 3)

Lifecycle Stages	Stockholm Convention POPs				US EPA PBTs				OSPAR + US EPA Priority Chemicals			
	PVC	ABS	HDPE & PEX	PP	PVC	ABS	HDPE & PEX	PP	PVC	ABS	HDPE & PEX	PP
--- Feedstock, Resin, Polymer, and Product Production (cont – polymerization & compounding --------												
ABS poly-merization & compounding	na	No data	na		na	No data	na		na	No data	na	
HDPE poly-merization & compounding	na		none	na	na		none	na	na		Water effluent, treated: PAHs	na
PP poly-merization & com-pounding	na			none	na			none	na			Water effluent, treated: DEHP, PAHs
PVC poly-merization & com-pounding	none	na			none	na			Lead, organotin compounds	na		
--- Product Use --------												
Accidental fires	dioxins / furans ++	none			dioxins / furans	No data			dioxins / furans	No data		
Normal use of Pipe	none				none				organotin or lead com-pounds	No data		
--- End of Life --------												
Landfill disposal	dioxins / furans +	none			dioxins / furans	No data			dioxins / furans	No data		
Incinerator disposal	dioxins / furans++	none			dioxins / furans	No data			dioxins / furans	No data		

na = not applicable to this plastic No data = no data collected for this topic none = none of these chemicals have been measured for this stage of this plastic

+ from landfill fires ++ chlorine is necessary for dioxin formation

Sources: Assessing the impacts of production and disposal of packaging and public policy measures to alter its mix (volume II). Boston: Tellus Institute. 1992
Thornton, Joe, PhD., Pandora's Poison. Cambridge, MIT Press. 2000

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Appendix 4 - Average Composition of PVC Sewer Pipes

Inputs	Entec UK Ltd, 2000 (%)	Intron Report #95027 (%)
PVC	92.1	94
Stabilizers		
- tribasic lead sulphate	1.4	
- dibasic lead stearate	0.5	
- lead stearate	0.2	1.1
- lead stearate	0.4	
- lead stailizer		
- tin stabilizer		
Plasticizer		
Filler		3.8
- powdered limestone	4.7	
Stearic acid	0.1	
Synthetic hard wax	0.1	
Paraffin (lubricant)		0.7
Pigment		
- carbon black	0.5	0.2
- titanium dioxide		0.2
Total	100	100

Source: Baitx, Martin, et. al. 2004. Life Cycle Assessment of PVC and of Principal Competing Materials. Brussels: European Commission.

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Appendix 5 - Additives that may be Used with Plastic Pipes

	PVC	ABS	PEX	HDPE	PP
Antioxidants					
		0.1-1.0% by weight of polymer resin		0.15% by weight of polymer resin	0.05-0.25% by weight of polymer resin
		-- Phenolics	-- Phenolics	-- Phenolics	-- Phenolics
	-- Phosphites	-- Phosphites and phosphonites	-- Phosphites	-- Phosphites	-- Phosphites and phosphonites
		-- Thioesters			-- Thioesters
Antistatic agents					
	--	-- Ethoxylated amines	-- Ethoxylated amines	-- Ethoxylated amines	-- Ethoxylated amines
	-- Fatty acid ester		-- Fatty acid ester	-- Fatty acid ester	-- Fatty acid ester
	-- Alkylsufonate	-- Alkylsufonate			
	-- Quaternary ammonium compounds				
Lubricants					
	-- Calcium stearate	-- Zinc stearate	-- Zinc stearates	-- Zinc stearates	-- Zinc stearates
	--	-- Fatty acid amides	-- Fatty acid amides	-- Fatty acid amides	-- Fatty acid amides
	-- Fatty acids and fatty esters		-- Fatty acids	-- Fatty acids	-- Fatty acids
	-- Hydrocarbon waxes: paraffins				
UV light stabilizers					
	-- Carbon black	-- Carbon black	-- Carbon black	-- Carbon black	-- Carbon black
		-- Benzophenones			-- Benzophenones
		-- Hindered amine light stabilizers (HALS)			-- Hindered amine light stabilizers (HALS)
Stabilizers					
	- Lead-based stabilizers	-- na	-- na	-- na	-- na
	-- Organotins				
	-- Cadmium**				
	-- Calcium-zinc				
"na" = not applicable					

Sources:
- Modler, Robert, Eric Anderson, and Yosuke Ishikawa. Chemical Economics Handbook, "Plastics Additives," Palo Alto, CA: SRI International. 1997.
- The Plastics Pipe Institute. 1999. Weatherability of Thermoplastic Piping Systems. Washington, DC: The Plastics Pipe Institute.
- Zweifel, Hans (ed.). 2000. Plastics Additives Handbook (5th Edition). Munich: Hanser Publications
- Special Chem database, www.specialchem4polymers.com/resources/search

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Appendix 6 - Toxicity of Inputs

Plastics	Chemical Inputs	Carcinogens (multiple lists)	Mutagens (EU CMR List)	Reproductive / Developmental Toxicants (EU CMR List + CA Prop 65)	Endocrine Disruptors (EU Draft List)	Persist-ence (EU List)	Bio-accumul ative Capacity (EU List)
ABS	Acrylonitrile	I-2B, N-2, CP65, EU-2					
ABS	Alkylsulfonate (antistatic)	*Need to know the specific chemicals used. But toxicity data are likely to be absent. For example, no toxicity data have been evaluated for "sodium dodecylbenzene sulfonate-iodine complex" (CAS# 53467-01-9) (Pesticides Action Network, "Pesticides Database - Chemicals," 2004).*					
ABS, HDPE, PEX, PP	Fatty acid amides (lubricant)	*Need to know specific chemical. But toxicity data are likely to be absent. For example, no toxicity data have been evaluated for "diethanolamides of the fatty acids of coconut oil" (RTECS, 2003).*					
ABS	Benzene	I-1, N-1, CP65, EU-1		CP65			
ABS, PP	Benzo-phenones	*Need to know the specific chemical used. For example,* bis(dimethyl-amino) benzophenone is a NTP-2 and CP65 carcinogen.					
ABS	Butadiene, 1-3	I-2A, N-1, CP65, EU-1	EU-2	CP65			
PVC	Cadmium (Cd) Compounds	I-1, N-1, CP65, EU-2	EU-2 (selected Cd compounds) [CP65 - Cd, yes; Cd compounds, no]	EU Category 2 (selected Cd compounds)		Metal	
PVC	Chlorine						
ABS, HDPE, PEX, PP, PVC	Carbon Black	I-2B, CP65					
ABS, HDPE, PP	Ethoxylated amine (antistatic)	*Need to know specific chemical. But toxicity data are likely to be absent. For example, no toxicity data have been evaluated for "amines, tallow, ethoxylated, carboxylated" (CAS#: 61791-25-1) (RTECS, 1999).*					
ABS	Ethylbenzene	I-2B					
ABS, HDPE, PEX, PVC	Ethylene						
PVC	Ethylene Dichloride (EDC)	I-2B, N-2, CP65, EU-2					
HDPE, PEX, PP	Fatty acids and esters (antistatic + lubricant)	*Need to know specific chemical. But toxicity data are likely to be absent. For example, no toxicity data have been evaluated for "fatty acids, coconut oil, sulfoethyl esters, sodium salts" (CAS# 61789-32-0) (RTECS, 1997).*					
ABS, PP	Hindered amine light stabilizers (HALS)	*The US EPA, TSCA New Chemicals Program, concluded in 2001 that the category "Hindered Amines" is "at present not well defined." Health concerns for the category, according to the EPA are based on data submitted for Tinuvin 144 and Chimassorb 944: "The data indicate that these hindered amines, and presumably hindered amines similar in structure, are toxic to the immune system, liver, blood, the male reproductive system, and the G.I. tract" (US EPA, 2001). However, HALS are not listed by either the EU or Prop 65 as reproductive/developmental toxicants.*					
PVC	Lead Compounds	I-2B, CP65		EU-1 (selected lead com-pounds); [CP65 - lead, only no compounds		Metal	

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Plastics	Chemical Inputs	Carcinogens (multiple lists)	Mutagens (EU CMR List)	Reproductive / Developmental Toxicants (EU CMR List + CA Prop 65)	Endocrine Disruptors (EU Draft List)	Persist-ence (EU List)	Bio-accumul ative Capacity (EU List)
PVC	Organotins				EU-1	Metal	
PVC	Paraffin (lubricant)	*Limited carcinogenicity studies have been done on paraffin (CAS# 8002-74-2) fumes, but none of the lists assessed here include paraffin as a carcinogen.*					
ABS, HDPE, PEX, PP	Phenolics (antioxidant)	*Need to know the specific chemical used. For example Bisphenol A (CAS #: 80-05-7) is a Category 1 endocrine disruptor in the EU.*					
ABS, HDPE, PEX, PP	Phosphites (antioxidant)	*Need to know specific chemical. But toxicity data are likely to be absent. For example, no chronic toxicity data are available for "bis(2-ethylhexyl) phosphite" (CAS#: 3658-48-8) (RTECS, 1997).*					
PP	Propylene						
PVC	Quaternary ammonium compounds	*No chronic toxicity data available (RTECS, 2003), yet there is evidence that these compounds can cause occupational asthma (Purohit, et al., 2000)*					
ABS	Styrene Monomer	I-2B			EU-1		
ABS, PP	Thioesters (antioxidants)	*Need to know specific chemical. But toxicity data likely to be absent. E.g., no chronic toxicity data available for "methyl demeton thioester" (CAS#: 919-86-8) (RTECS, 1997).*					
PVC	Vinyl Chloride Monomer(VCM)	I-1, N-1, CP65, EU-1					
ABS, HDPE, PEX, PP	Zinc stearate (lubricant)						

"Blank cells" = no data found for that endpoint

Carcinogen abbreviations

"I": International Agency for Research on Cancer (World Health Organization)
- I-1: Carcinogenic to humans
- 2A: Probably carcinogenic to humans
- 2B: Possibly carcinogenic to humans

"N": National Toxicology Program (Health and Human Services Dept., Public Health Service, NIH/NIEHS
- 1: Known to be carcinogenic
- 2: Reasonably anticipated to be carcinogens

"CP65": California Proposition 65 - Chemicals Known to the State to Cause Cancer

"EU": European Union Consolidated List of C/M/R Substances
- 1: Category 1
- 2: Category 2

Mutagens

"EU CMR List": European Union Consolidated List of C/M/R [Carcinogen/Mutagen/Reproductive toxicant] Substances"

Reproductive / Developmental Toxicants

"EU CMR List": European Union Consolidated List of C/M/R Substances"

"CP65": California Proposition 65 - Chemicals known to the state to be developmental / reproductive toxicants

Endocrine Disruptors

European Union (EU) "Candidate List of Substances" (2000)
- "EU-1": Category 1: At least one study providing evidence of endocrine disruption
- "EU-2": Category 2: Potential for endocrine disruption

Persistence & Bioaccumulative Capacity

Swedish National Chemicals Inspectorate (Kemi)

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Appendix 7 - Performance Comparison of Pipe Plastics

Comparative Technical Data for the Pipe Plastics [69]								
Type of Plastic	Density, g/cm³ (ASTM D 792)	Coefficient of Thermal Expansion, 10^{-6}/°C (ASTM D 696)	Tensile Strength, (psi) (ASTM D 638)	Compressive Strength, (psi) (ASTM D 695)	Temperature Limits (F) Pressure applications	Temperature Limits (F) Non pressure applications	Flexural Strength, (psi) (ASTM D 790)	Modulus of Elasticity, (10^5·psi) (ASTM D 638)
PVC	1.38	50	7,000	9,600	158	179 (210 CPVC)	14,500	4.5
HDPE	0.95	130	2,800	3600	140	194	2,000	0.20
ABS	1.04	101	5,500	7,700	158	176	10,000	3.1
PEX[70]	0.95	141	3,900		210	210[71]	15,000	1.5
PP	0.91	68	4,900	8,500	180	194	8,500	1.5

The following tables provide an overview of important design and operational considerations for the plastics in various pipe sectors:

Water and Pressure Sanitary					
	PVC	ABS*	PEX	HDPE	PP**
Durability	G	N/A	G	G	G
Joint integrity	G	N/A	E	E	E
Pressure rating		N/A	G	G	G
Abrasion resistance	G	N/A	E	E	E
Chemical resistance	G	N/A	No data	E	E
*ABS is not generally used for pressure applications. ** PP is widely available in Europe, but just beginning to be marketed in North America.					

DWV					
	PVC	ABS	PEX*	HDPE**	PP**
Durability	G	G	N/A	G	G
Joint integrity	G	G	N/A	E	E
Pressure rating	G	P	N/A	G	G
Abrasion resistance	G	No data	N/A	E	No data
Chemical resistance	G	G	N/A	E	E
* The flexibility and other considerations preclude the use of PEX for use in this sector. **HDPE is not generally used for this application. PP is just beginning to be marketed in North America					

[69] [69] National Resource Council of Canada website http://irc.nrc-cnrc.gc.ca/cbd/cbd220e.html
[69] http://www.vanguard.ca/products/canplumb.pdf
[69] Suggested Temperature Limits for the Operation and Installation of Thermoplastic Piping in Non-Pressure Applications TN-11/99 http://www.plasticpipe.org/pdf/pubs/notes/TN11-99.PDF
[70] Vanguard pipes http://www.vanguard.ca/products/canplumb.pdf
[71] Suggested Temperature Limits for the Operation and Installation of Thermoplastic Piping in Non-Pressure Applications TN-11/99 http://www.plasticpipe.org/pdf/pubs/notes/TN11-99.PDF

Sanitary Sewer (Gravity)					
	PVC	ABS	PEX*	HDPE	PP**
Durability	G	G	N/A	G	G
Joint integrity	G	G	N/A	G	G
Pressure rating	G	P	N/A	G	G
Abrasion resistance	G	No data	N/A	E	E
Chemical resistance	G	G	N/A	E	E

* The flexibility and other considerations preclude the use of PEX for Sanitary Sewer.
** PP sanitary pipe is widely available in Europe but just beginning to be marketed in North America

Storm Sewer					
	PVC	ABS*	PEX**	HDPE	PP***
Durability	G	N/A	N/A	G	G
Joint integrity	G	N/A	N/A	E	E
Pressure rating	G	N/A	N/A	G	G
Abrasion resistance	G	N/A	N/A	E	E
Chemical resistance	G	N/A	N/A	E	E

*ABS is not generally available for Storm Sewer Applications. T
** The flexibility and other considerations preclude the use of PEX for Storm Sewer.
*** PP is generally not marketed for storm sewer applications.

Irrigation and Drainage					
	PVC	ABS **	PEX*	HDPE	PP***
Durability	G	G	N/A	G	G
Joint integrity	G	G	N/A	E	E
Pressure rating	G	P	N/A	G	G
Abrasion resistance	G	No data	N/A	E	No data
Chemical resistance	G	G	N/A	E	E

* The flexibility and other considerations preclude the use of PEX for use in this sector.
**ABS is generally not used for irrigation and drainage applications
*** While PP is frequently used for fittings in this market it is not typically used for irrigation or drainage pipes

As these tables demonstrate, ABS and PEX have particular niche markets and the rest of the plastics are competitive across applications from a performance perspective.

References for rankings in tables:

- Chemical resistance: http://irc.nrc-cnrc.gc.ca/cbd/cbd220e.html reference for
- Abrasion and chemical resistance http://www.cheresources.com/plpipezz.shtml
- Joint integrity and durability and chemical resistance and abrasion http://www.on.ec.gc.ca/water/greatlakes/data/chlor-alkali

Appendix 8 - Glossary of Abbreviations

ABS	Acrylonitrile-butadiene-styrene
ASTM	American Society for Testing and Materials
Cd	Cadmium
CMR	Carcinogen, mutagen or reproductive toxicant
CPVC	Crosslinked polyvinyl chloride
DBP	Dibutyl phthalate
DEHP	Di(2-ethylhexyl) phthalate
DWV	Drain-waste and vent
EDC	Ethylene dichloride
EU	European Union
HDPE	High density polyethylene
Hg	Mercury
IARC	International Agency for Research on Cancer
LCA	Life Cycle Assessment
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
OSPAR	Oslo-Paris Convention for the Protection of the Marine Environment of the North East Atlantic
PAH	Polyaromatic hydrocarbon
Pb	Lead
PBT	Persistent Bioaccumulative Toxic
PCB	Polychlorinated biphenyls
PCP	Pentachloro-phenol
PET or PETE	Polyethylene terephthalate
PEX	Cross linked polyethylene
POP	Persistent organic pollutant
PP	Polypropylene
PVC	Polyvinyl chloride
Stockholm	Stockholm Convention on Persistent Organic Pollutants
TRI	Toxic Release Inventory (US EPA)
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
VCM	vinyl chloride monomer

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DRAFT

Doug Hensel

From: Bill Staack
Sent: Wednesday, November 03, 2004 3:21 PM
To: Doug Hensel
Subject: Adhesive used

Doug. Could you develop a simi-accurate estimate on the amount of adhesive would be used in a house to install CPVC water pipe and what is being used for Waste/Drain/Vent pipe. As an assumed example: the Waste/Drain/Vent pipe uses a 5 pound can of adhesive and CPVC would add another 1 pound can. That is what I am looking for.

Thanks.

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Doug Hensel

From: Bill Staack
Sent: Monday, November 08, 2004 7:34 AM
To: Doug Hensel
Subject: Adhesives product used

Doug. I if safe to say that approximately 2 pound of adhesives are would be used to glue a typical residences with CPVC?

Bill Staack, Esq., P.E.
Senior Staff Counsel
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Doug Hensel

From: Bill Staack
Sent: Monday, November 08, 2004 9:26 AM
To: Jim McGowan; Dave Walls; Doug Hensel
Subject: Proposed sentence for CEQAS document of CPVC

An ARB's survey summary for pipe cements from consumer products indicates that adhesives product sold in California contains approximately 68 % VOC (also referred to as reactive organic gases or ROG, Consumer Products Regulation, section 94508, title 17 CCR). The Departments assumption that 2 pounds of adhesive product would be used to install CPVC in a residential unit there would be approximately 1.36 pounds of VOC emissions (0.68 x 2 pounds = 1.36 pounds per unit). Using the Construction Industry Research Boards estimates for one and two family and multifamily residents there are could be approximately 550 units per day using CPVC instead of metallic pipe which would add 748 pounds or .37 tons per day. The ARB's 2004 Almanac Data for Reactive Organic Gases Projected Emission Statewide Inventory estimates for the year 2005 approximately 2461.663 tons per day of ROG (VOC). The potential increase of .27 tons per day of VOC from non-stationary sources, is only 0.01 percent of the projected emissions inventory for 2005 of VOC's.

Bill Staack, Esq., P.E.
Senior Staff Counsel
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Dave Walls

From: Bill Staack
Sent: Wednesday, April 21, 2004 1:43 PM
To: 'Bruce Fujimoto'
Cc: Dave Walls
Subject: CPVC Plastic Pipe and one-step primer/glues

Bruce. Is there anyone at the Board that I can find out if there is a regulatory discharge limit from homes concerning any of the solvents that would be leached into water by the one-step primer/glue that is used to cement CPVC plastic drinking water pipe?

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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-----Original Message-----
From: Dongmin Luo [mailto:dluo@arb.ca.gov]
Sent: Wednesday, December 08, 2004 11:07 AM
To: Bill Staack
Cc: mschwehr@arb.ca.gov; Dave Walls; Jim McGowan; Doug Hensel; Eileen McCauley
Subject: Re: Reactive Organic Gases (ROG) QUESTION - Propane and Acetylene

Yes, both propane and acetylene are considered VOCs (or ROGs) in U.S. EPA as well as ARB since both are more photochemically reactive than the benchmark compound (ethane). Let me know if you need more info.

Dongmin

--
Dongmin Luo, Ph.D., P.E.
Research Division
California Air Resources Board
1001 I Street, 5th floor
Sacramento, CA 95814
Tel (916) 324-8496
Fax (916) 323-1045

Beth Schwehr wrote:

Hi Bill,
For some reason my earlier email response did not send properly, so I'll try again.

I will cc Dongmin Luo in our Research Division who is the point of contact now for reviewing VOC exemptions, to confirm my understanding, which is that propane and acetylene would be considered VOCs under the definition of VOC, and likewise for ROG.
Dongmin, could you please confirm? Thanks.

Keep in mind of course, that for actual ozone airshed modeling, the relative reactivities and chemical mechanisms are used, as explained in the Fact Sheets on our speciation web page that you mentioned (see under TOG and ROG Background Documents, FACT_SHEETS).

Beth

Bill Staack wrote:

Beth. I was looking at the following table from your web page (your email address was listed at the bottom of the table):

ARB's Definitions of TOG and ROG (as of November 2004):

Total Organic Gases (TOG)means compounds of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides

or carbonates, and ammonium carbonate.

Reactive Organic Gases (ROG) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid,

metallic carbides or carbonates, and ammonium carbonate, and excluding the following:

I did not see either propane or acetylene listed as an exclusion to the ROG's. Does this mean that propane and acetylene are ROG's?

I am working on an environmental document and need this answered. Can you help me or give this to someone at the ARB that can help me.

Thanks.

Bill Staack, Esq., P.E.

Senior Staff Counsel
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Doug Hensel

From: Bill Staack
Sent: Tuesday, November 09, 2004 7:37 AM
To: Doug Hensel
Subject: RE: Adhesives product used

Thanks Doug.

-----Original Message-----
From: Doug Hensel
Sent: Tuesday, November 09, 2004 7:35 AM
To: Bill Staack
Subject: RE: Adhesives product used

I talked to Harry and he used 2 ½ pints of CPVC cement to do a 3bdrm, 3bath home. He was going to get back to me regarding the amount used for ABS and never did, my guess and experience is that about 1 ½ 16 oz containers would be used for the same house to do the drain, waste , and vent piping.

Doug Hensel
District Representative II
California Department of
Housing and Community Development
Division of Codes and Standards
(916)445-9471 ~ fax: (916)327-4712
dhensel@hcd.ca.gov

Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Friday, April 23, 2004 8:38 AM
To: Bill Staack
Cc: Alan Watson; Harry Moos; John Taul; Kristin Ehlers
Subject: Re: One-step primers

Bill I have spoke to the makers of the Solvent Weld Cements and primers and according to the Bay Area air quality Management District and the Southcoast Air Quality Management the following are the standards for VOC's One-Step Cement 490Grams per litre Primer is 650 grams per Litre Two step Cement is 490 Grams per litre The combined two step process is over twice the exposure levels of VOC's than the one step process. Also handling storage and flushing are affected more adverse with the two step process.

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
The mitigated negative declaration for CPVC was based on a two step process for connections, i.e., primer and cement. I believe the new UPC list a one-step primer. Do you know how much different the chemical base is for these two different processes? Bill Staack, Esq., P.E. Legal Affairs Division Department of Housing and Community Development (916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Thursday, April 22, 2004 9:23 AM
To: Bill Staack
Subject: Re: One-step primers

Don this is the E-mail I spoke of thanks Garry

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
The mitigated negative declaration for CPVC was based on a two step process for connections, i.e., primer and cement. I believe the new UPC list a one-step primer. Do you know how much different the chemical base is for these two different processes? Bill Staack, Esq., P.E. Legal Affairs Division Department of Housing and Community Development (916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Friday, April 23, 2004 8:38 AM
To: Bill Staack
Cc: Alan Watson; Harry Moos; John Taul; Kristin Ehlers
Subject: Re: One-step primers

Bill I have spoke to the makers of the Solvent Weld Cements and primers and according to the Bay Area air quality Management District and the Southcoast Air Quality Management the following are the standards for VOC's One-Step Cement 490Grams per litre Primer is 650 grams per Litre Two step Cement is 490 Grams per litre The combined two step process is over twice the exposure levels of VOC's than the one step process. Also handling storage and flushing are affected more adverse with the two step process.

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
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e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Thursday, April 22, 2004 9:08 AM
To: Bill Staack
Subject: Re: One-step primers

Bill the one step Cement process is a process that has no primer. The one step solvent weld cement has a significantly lower cure time. It also has a lower VOC rating compared to primer and cement process. This also reduces exposure to the installer the primer process. One step cure time is approximately 5 to 10 minutes for 100lbs. where it takes approximately 45 minutes with the two step process. The new UPC is one step process.

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
The mitigated negative declaration for CPVC was based on a two step process for connections, i.e., primer and cement. I believe the new UPC list a one-step primer. Do you know how much different the chemical base is for these two different processes? Bill Staack, Esq., P.E. Legal Affairs Division Department of Housing and Community Development (916) 323-7288
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 </html>

From: Brausch, Rick [RBrausch@CALEPA.ca.gov]
Sent: Thursday, April 29, 2004 2:51 PM
To: Bill Staack
Subject: RE: Question for ARB

COPY

[redacted]

For your question about PVC cement, I'd check with ARB's Consumer Products folks (http://www.arb.ca.gov/consprod/consprod.htm). Peter D. Venturini is the Chief, and would be a good guy to start with [(916) 445-0650]. Otherwise, the rest of the program's contacts are at http://www.arb.ca.gov/consprod/contact.htm.

Hope all is well with you. Sounds like HCD is treating you well. Let me know if you need anything else.

Rick

-----Original Message-----
From: Bill Staack [mailto:BStaack@hcd.ca.gov]
Sent: Wednesday, April 21, 2004 4:03 PM
To: Brausch, Rick
Subject: Question for ARB

[redacted]

Hope you don't mind me asking but I see you are in External Affairs at CalEPA and maybe know the contact person I'm looking for at the ARB.

I need some help answering the below question through the ARB.

Is there anyone at the Board that I can find out if there is a regulatory limit (i.e., air toxic contaminant level, or VOC limits) from the use of a one-step primer/glue that is used to cement CPVC plastic drinking water pipe? This may be an important issue because it concerns the expanded use of CPVC plastic pipe in California, which has a similar issue that another plastic pipe called PEX has been dealing with. FYI, PEX was the 5 item on the new Governors homepage of issues he wanted resolved when he became Governor.

Any help with a contact would be great.

Thanks

Bill Staack, Esq., P.E.

Legal Affairs Division

Department of Housing and Community Development

(916) 323-7288

e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Beth Schwehr [mschwehr@arb.ca.gov]
Sent: Wednesday, December 08, 2004 10:49 AM
To: Bill Staack; Dongmin Luo
Cc: Dave Walls; Jim McGowan; Doug Hensel; mschwehr@arb.ca.gov
Subject: Re: Reactive Organic Gases (ROG) QUESTION - Propane and Acetylene

Hi Bill,
For some reason my earlier email response did not send properly, so I'll try again.

I will cc Dongmin Luo in our Research Division who is the point of contact now for reviewing VOC exemptions, to confirm my understanding, which is that propane and acetylene would be considered VOCs under the definition of VOC, and likewise for ROG.
Dongmin, could you please confirm? Thanks.

Keep in mind of course, that for actual ozone airshed modeling, the relative reactivities and chemical mechanisms are used, as explained in the Fact Sheets on our speciation web page that you mentioned (see under TOG and ROG Background Documents, FACT_SHEETS).

Beth

Bill Staack wrote:

Beth. I was looking at the following table from your web page (your email address was listed at the bottom of the table):

ARB's Definitions of TOG and ROG (as of November 2004):
Total Organic Gases (TOG)means compounds of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides

or carbonates, and ammonium carbonate.
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I did not see either propane or acetylene listed as an exclusion to the ROG's. Does this mean that propane and acetylene are ROG's?

I am working on an environmental document and need this answered. Can you help me or give this to someone at the ARB that can help me.

Thanks.

Bill Staack, Esq., P.E.
Senior Staff Counsel
Legal Affairs Division

3/1/2005

Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Dongmin Luo [dluo@arb.ca.gov]
Sent: Wednesday, December 08, 2004 11:07 AM
To: Bill Staack
Cc: mschwehr@arb.ca.gov; Dave Walls; Jim McGowan; Doug Hensel; Eileen McCauley
Subject: Re: Reactive Organic Gases (ROG) QUESTION - Propane and Acetylene

Yes, both propane and acetylene are considered VOCs (or ROGs) in U.S. EPA as well as ARB since both are more photochemically reactive than the benchmark compound (ethane). Let me know if you need more info.

Dongmin

--
Dongmin Luo, Ph.D., P.E.
Research Division
California Air Resources Board
1001 I Street, 5th floor
Sacramento, CA 95814
Tel (916) 324-8496
Fax (916) 323-1045

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Bill Staack

From: Don Rake [drake@arb.ca.gov]
Sent: Monday, November 08, 2004 6:32 AM
To: Bill Staack
Subject: Re: [Fwd: Adhesive Inventory]

Don Rake wrote:

It seems that no one here has done any in-depth analysis of adhesives since the mid-80s. The Bay Area Air Quality has done some more recent work, around 1999. You might contact J. Elliott (sorry, first name is not listed) at 415-749-4705 or D. Jang at 415-749-4707.

Subject: Adhesive Inventory
Date: Wed, 03 Nov 2004 08:15:10 -0800
From: Bill Staack <BStaack@hcd.ca.gov>
To: eibweb@arb.ca.gov

I need to discuss with someone at the ARB information I need concerning increasing emissions from the use of adhesives. I am looking for an emission inventory estimate for a CEQA document I am preparing. I am discussing the use of adhesives to join CPVC plastic pipe in a residential building. I want to generate numbers for existing emissions inventory of all VOC from emission used by the construction industry and compare that number with the expected VOC increase from an estimated new emission from 100,000 new homes per year that would install CPVC plastic pipe with adhesives.

Can you help me with generating such comparison? My belief is that the added emissions would not be measurable in an air quality model.

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Judy Yee [jyee@arb.ca.gov]
Sent: Friday, November 05, 2004 1:48 PM
To: Bill Staack
Subject: Contact for ARB Emission Inventory

Bill,

Andrew Delao, (916) 324-7169, PTSD, adelao@arb.ca.gov
See the note below and check out this location:
http://www.arb.ca.gov/ei/areasrc/fullpdf/full3-7.pdf

Judy
-------- Original Message --------
Subject: Re: Large size adhesives
Date: Thu, 23 Sep 2004 10:29:45 -0700
From: Andy Delao <adelao@arb.ca.gov>
Reply-To: adelao@arb.ca.gov
Organization: California Air Resources Board
To: Judy Yee <jyee@arb.ca.gov>, Mike Benjamin <mbenjami@arb.ca.gov>
CC: Steve Giorgi <sgiorgi@arb.ca.gov>, Carla Takemoto <ctakemot@arb.ca.gov>,David Mallory <dmallory@arb.ca.gov>
References: <4152018F.FE0E3073@arb.ca.gov> <4152E87E.167496B@arb.ca.gov>

Hi Judy,

Here is what I know about what's in the areawide source inventory for adhesives and sealants (in additions to what is included under consumer products). We have 2 area source categories (solvent-based and water-based); the emissions for these ARB categories are based on 1980's data. According to the methodology (http://www.arb.ca.gov/ei/areasrc/fullpdf/full3-7.pdf), the adhesives/sealants are used for construction, transportation, and other industries. Also, the emissions from the packaging and wood converting industries were assumed to be accounted for in the point source inventory. The methodology doesn't address product size but I would assume that the larger sizes would be accounted for here and under the point source inventory. Currently, there is a point source category being used by districts, according to the online Almanac.

As far as how districts apply their adopted limits for the larger sizes to the existing inventory data...Michael, is that info that your section could provide to Judy? Or would it be better to contact the districts directly?

Judy Yee wrote:

> Hi Andy,
>
> We trying to confirm that the large adhesives sizes are reported
> somewhere in the inventory. Does anyonne know or able to confirm that
> these emissions are included in district reported emissions? Would we
> need to talk to district staff?
>
> Thanks, Judy
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> Andy Delao wrote:
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> > passed along to me. I spoke with Ray Asregadoo who worked on the 1997
> > consumer products survey. His recollection is that these larger
> > sizes (> 16 fluid and wt. oz.) are excluded from the consumer products

> > inventory. Steve, does this match your recollection?
> >
> > Andy
>
> --
> Judy Yee
> Manager, Implementation Section
> Stationary Source Division
> California Air Resources Board
> 1001 I Street
> P.O. Box 2815
> Sacramento, CA 95812
>
> (916) 322-9148 Telephone
> (916) 327-5634 Fax
> jyee@arb.ca.gov E-mail
>
> ==========
> The energy challenge facing California is real. Every Californian
> needs to take immediate action to reduce energy consumption. For a
> list of simple ways you can reduce demand and cut your energy cost,
> see our web site at http://www.arb.ca.gov.

Bill Staack

From: Judy Yee [jyee@arb.ca.gov]
Sent: Friday, November 05, 2004 4:07 PM
To: Bill Staack
Subject: Pipe cement sales from 1997 survey

Hi Bill,

See this link for the 1997 survey summary of all categories surveyed: http://www.arb.ca.gov/consprod/regact/ccps/ccps.pdf. For the pipe cements, there were about 1.76 tons per day of product sold and ROG emissions were 1.19 tons per day. Therefore, the average ROG (VOC) content was 68 %. The range reported was 0-100% (this excludes compounds considered LVP-VOCs (low vapor pressure volatile organic compounds)

These values do not include product, less packaging, that weigh more than 1 pound and consist of more than 16 fluid ounces (see definition of adhesive in the Consumer Products Regulation, section 94508, title 17 CCR . If you want to add in the larger sizes that were reported in the 1997 survey, you can multiply the values by 2.3. Per our discussion, some companies may not have reported the larger sizes, the total is at least 2.3 times the 1997 summary values.

We typically grow our consumer products emissions by California population growth from the Department of Finance. Our emission inventory website provides a population info tool at http://www.arb.ca.gov/app/emsinv/trends/ems_trends.php. However, I think our architectural coating folks, use housing growth to grwoth the arch coating emissions. Regardless, you need to grow the emissions to whate ever year you will be covering in the CEQA eval.

If you need a list of companies that responded to the survey or a couple of manufacturers that would be good contacts, let me know.

Regards, Judy

Bill Staack

From: eibweb [eibweb@arb.ca.gov]
Sent: Friday, November 05, 2004 10:27 AM
To: Bill Staack
Subject: Re: Information concerning adhesive inventory

I forwarded your requests to Jose Gomez, jgomez@arb.ca.gov.

Bill Staack wrote:

> I sent in a request a few days ago concerning the emission inventory of VOC in adhesives. I need this information for a CEQA document that my Department is preparing. Could you provide me with a contact person to seek a response to my inquiry?
>
> Thanks

Bill Staack, Esq., P.E.
Senior Staff Counsel
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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> The energy challenge facing California is real. Every Californian
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> see our web site at http://www.arb.ca.gov.

Bill Staack

From: Harry Moos [Harry.Moos@Noveon.com]
Sent: Tuesday, October 26, 2004 6:26 AM
To: Bill Staack
Subject: RE: Estimate annual use of CPVC for new construction

Bill, In the last 40 years more than (3) billion feet of CPVC pipe has been installed in homes, Condominiums, apartments, and hotels, including (8) million homes. For the last 4 to 5 years of course excluding California due to the deal we would estimate the following: approx 1,000,000. Homes in the last five years in residential construction as in Florida and other states have exploded with the use of CPVC.

-----Original Message-----
From: Bill Staack [mailto:BStaack@hcd.ca.gov]
Sent: Thursday, October 21, 2004 3:18 PM
To: Harry Moos
Subject: Estimate annual use of CPVC for new construction

Harry. Are there estimates in you industry for the amount of CPVC that has been used in new residential construction, (not re-piping as I asked before) in the last 4 or 5 years.

Thanks.

Bill Staack, Esq., P.E.
Legal Affairs Division
Department of Housing and Community Development
(916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Dave Walls
Sent: Tuesday, September 28, 2004 4:09 PM
To: Bill Staack
Subject: FW: Repiping

Dave Walls, CSA1
State Housing Law Program Manager
Department of Housing and Community Development
Division of Codes and Standards (916) 445-9471

-----Original Message-----
From: Bill Staack
Sent: Wednesday, September 15, 2004 3:14 PM
To: Jim McGowan; Chris Anderson; Dave Walls; Doug Hensel; Kevin Reinertson; Ron Bergeson
Subject: Repiping

I requested from Noveon, Inc any information that had on plumbers repiping homes with metallic pipe problems. They sent me the following information on southern California that was obtained from plumbing companies that repipe.

Orange County	10,000 yearly
LA County	15,000 yearly
San Diego County	10,000 yearly
Riverside County	9,000 yearly
San Bernardino	12,000 yearly
Ventura/Santa Barbara	8,000 yearly
Kern County	4,000 yearly

Orange County Ace Duraflow estimated 90% copper pipe replacement and 10% galvanized.

Bill Staack, Esq., P.E.
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Bill Staack

From: John DaMassa [jdamassa@arb.ca.gov]
Sent: Thursday, March 03, 2005 10:20 AM
To: Bill Staack
Cc: Bob Fletcher; Ajith Kaduwela; Vernon Hughes
Subject: Re: Sensitivity of Air Quality Models

Bill,

ARB's Board-approved modeling guidance ("TECHNICAL GUIDANCE DOCUMENT: Photochemical Modeling", 4/92, page VII-2) recommends that photochemical models may be used on a case by case basis to evaluate control measures when the change in average emission density over the entire modeling domain is 1-5% or greater. Use of models for smaller emission changes requires additional technical justification.

I hope this helps. Please let me know if you have any additional questions or if anything is unclear. Take care.

- John

Bill Staack wrote:

> John. I would like to confirm with you that there is a general rule that the sensitivity of an air model for ROGs is in the range of 1 to 5% of the inventory.

Bill Staack Esq., P.E.
Senior Staff Counsel
Legal Affairs Division
Department of Housing and Community Development
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Regards, Judy

J damassa @

ARB

John DeMassa

ROG

324-7167

Tons

1 to 5%

in 2 Yrs,

'om: Judy Yee [jyee@arb.ca.gov]
ent: Monday, May 17, 2004 2:49
o: Bill Staack
c: Janette Brooks
ubject: PVC pipe cements

Bill,

a voice from the past. Give me a call.

dy Yee

dy Yee
anager, Implementation Section
ationary Source Division
alifornia Air Resources Board
01 I Street
O. Box 2815
acramento, CA 95812

16) 322-9148 Telephone
16) 327-5634 Fax
e@arb.ca.gov E-mail

==========
nette Brooks wrote:

Judy: Please handle for us.
- Janette

-------- Original Message --------
Subject: [Fwd: Air Toxics Question]
Date: Mon, 17 May 2004 09:02:34 -0700
From: "Daniel E. Donohoue" <ddonohou@arb.ca.gov>
Organization: California Air Resources Board
To: Janette Brooks <jbrooks@arb.ca.gov>
CC: Bill Staack <BStaack@hcd.ca.gov>

Janette:

Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Friday, April 23, 2004 8:38 AM
To: Bill Staack
Cc: Alan Watson; Harry Moos; John Taul; Kristin Ehlers
Subject: Re: One-step primers

Bill I have spoke to the makers of the Solvent Weld Cements and primers and according to the Bay Area air quality Management District and the Southcoast Air Quality Management the following are the standards for VOC's One-Step Cement 490Grams per litre Primer is 650 grams per Litre Two step Cement is 490 Grams per litre The combined two step process is over twice the exposure levels of VOC's than the one step process. Also handling storage and flushing are affected more adverse with the two step process.

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
The mitigated negative declaration for CPVC was based on a two step process for connections, i.e., primer and cement. I believe the new UPC list a one-step primer. Do you know how much different the chemical base is for these two different processes? Bill Staack, Esq., P.E. Legal Affairs Division Department of Housing and Community Development (916) 323-7288
e-mail: BStaack@hcd.ca.gov

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Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Thursday, April 22, 2004 9:23 AM
To: Bill Staack
Subject: Re: One-step primers

Don this is the E-mail I spoke of thanks Garry

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
The mitigated negative declaration for CPVC was based on a two step process for connections, i.e., primer and cement. I believe the new UPC list a one-step primer. Do you know how much different the chemical base is for these two different processes? Bill Staack, Esq., P.E. Legal Affairs Division Department of Housing and Community Development (916) 323-7288
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Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Friday, April 23, 2004 8:38 AM
To: Bill Staack
Cc: Alan Watson; Harry Moos; John Taul; Kristin Ehlers
Subject: Re: One-step primers

Bill I have spoke to the makers of the Solvent Weld Cements and primers and according to the Bay Area air quality Management District and the Southcoast Air Quality Management the following are the standards for VOC's One-Step Cement 490Grams per litre Primer is 650 grams per Litre Two step Cement is 490 Grams per litre The combined two step process is over twice the exposure levels of VOC's than the one step process. Also handling storage and flushing are affected more adverse with the two step process.

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
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Bill Staack

From: Garry Gage [Garry.Gage@noveoninc.com]
Sent: Thursday, April 22, 2004 9:08 AM
To: Bill Staack
Subject: Re: One-step primers

Bill the one step Cement process is a process that has no primer. The one step solvent weld cement has a significantly lower cure time. It also has a lower VOC rating compared to primer and cement process. This also reduces exposure to the installer the primer process. One step cure time is approximately 5 to 10 minutes for 100lbs. where it takes approximately 45 minutes with the two step process. The new UPC is one step process.

>>> "Bill Staack" <BStaack@hcd.ca.gov> 04/22/04 07:53AM >>>
The mitigated negative declaration for CPVC was based on a two step process for connections, i.e., primer and cement. I believe the new UPC list a one-step primer. Do you know how much different the chemical base is for these two different processes? Bill Staack, Esq., P.E. Legal Affairs Division Department of Housing and Community Development (916) 323-7288
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Definitions of VOC and ROG

Last Revised September 2004

1. U.S. EPA Definition of VOC (Volatile Organic Compounds):

The U.S. Environmental Protection Agency (U.S. EPA) defines and uses the term Volatile Organic Compounds (VOC). The term VOC is defined in the Federal Register. The original definition of VOC made reference to the vapor pressure of the compounds (greater than 0.1 millimeter of mercury) as a determinant of volatility. However, the current definition relies solely on a list of exempted compounds having "negligible photochemical reactivity".

U.S. EPA periodically exempts additional compounds. A number of proposed exemptions are pending. A summary of petitions and rulemakings follows.

FINAL RULEMAKINGS AND OTHER ACTIONS:

- U.S. EPA exempted Methyl acetate, in response to petition from Eastman Chemical, April 9, 1998 (63 FR 17331), effective May 11, 1998.

- The Alliance for Responsible Atmospheric Policy, Arlington, Virginia, petitioned to exempt 22 compounds, primarily HFCs and HCFCs, but later withdrew five of these. U.S. EPA exempted 16 of the 17 requested compounds (excluding HCFC-150a). The final rule was published August 25, 1997 (62 FR 44900), effective September 24, 1997.

- In response to petitions, the U.S. EPA exempted HFC 43-10mee, HCFC 225ca, and HCFC 225cb. The final rule was published October 8, 1996 (61 FR 52848), and became effective November 7, 1996.

- Perchloroethylene was exempted by final rule published February 7, 1996 (61 FR 4588).

- Acetone was exempted by final rule published June 16, 1995 (60 FR 31633).

- U.S. EPA, OAQPS, held a workshop to evaluate aspects of its reactivity policy, such as a molar vs. gram basis for reactivity. The national workshop took place May 12-14, 1998 in North Carolina, and a Reactivity Research Working Group was formed to foster a public/private partnership to sponsor and guide scientific research regarding ozone reactivity.

PENDING RULEMAKINGS AND PETITIONS (as of June 18, 2004):

- Below is the list of Compounds for which U.S. EPA has Received Petitions Requesting VOC Exempt Status and for which U.S. EPA has Published no Final Action (as of June 18, 2004):

1. **1-Bromopropane** (also known as **n-propyl bromide**) - submitted by Enviro Tech International, Alameda, CA (submitted 5/10/96). Petition also submitted by Albemarle Corp., Baton Rouge, LA (submitted November 18, 1997)

2. **Methyl Bromide** - Chemical Manufacturers Association, Washington, DC (submitted (7/19/96)

3. **n-Alkanes (C_{12} - C_{18})** - The Aluminum Association, Washington, DC (submitted 11/27/96)

4. **Technical white oils** - The Printing Industries of America and Pennzoil Products Company (submitted 12/20/96)

5. **t-Butyl Acetate** - ARCO Chemical Company [now Lyondell] (submitted 1/17/97) ***[Proposed September 30, 1999, see 64 FR 52731]***

6. **Benzotrifluoride** - Occidental Chemical Company, Niagara Falls, NY (submitted 3/11/97). Also Kowa America Corp., New York, NY (submitted 7/29/02).

7. **Carbonyl Sulfide (COS)** - E.I. du Pont de Nemours and Company (submitted 8/11/97). Petition also submitted by Texas Mid-Continent Oil & Gas Association (submitted December 5, 1997)

8. **trans-1,2-dichloroethylene** - 3M Corporation, St. Paul, MN (submitted October 8, 1997)

9. **Dimethyl succinate** - Dibasic Esters Group, affiliated with the Synthetic Organic Chemical Manufacturers Association, Inc. (submitted October 14, 1997)

10. **Dimethyl glutarate** - Dibasic Esters Group, affiliated with the Synthetic Organic Chemical Manufacturers Association, Inc. (submitted October 14, 1997). Submitted in the same petition as for dimethyl succinate.

11. **Carbon Disulfide** - Texas Mid-Continent Oil & Gas Association, (submitted December 5, 1997)

12. **Acetonitrile** - BP Chemicals and GNI Chemicals Corporation, (submitted January 21, 1998)

13. **Toluene Diisocyanate (TDI)** - Chemical Manufacturers Association [The Diisocynate Panel of CMA reported the following members: ARCO Chemical Company, BASF Corporation, Bayer Corporation, The Dow Chemical Company, and ICI Americas, Inc.] (submitted January 22, 1998)

14. **HFC-227ea (1,1,1,2,3,3,3-heptafluoropropane)** - Great Lakes Chemical Corporation. (submitted February 18, 1998) ***[Proposed September 3, 2003, see 68 FR 52373]***

15. **Methylene Diphenyl Diisocyanate (MDI)** - Chemical Manufacturers Association [The Diisocynate Panel of CMA reported the following members: BASF Corporation, Bayer Corporation, The Dow Chemical Company, ICI Americas, Inc., and Lyondell Chemical Company], (submitted August 19, 1998)

16. **1,1,1,2,2,3,3-heptafluoro-3-methoxy-propane ($n\text{-}C_3F_7OCH_3$) (also known as HFE-7000)** - 3M Performance Chemicals and Fluids Division (submitted February 5, 1999) ***[Proposed September 3, 2003, see 68 FR 52373]***

17. **Propylene carbonate** - Huntsman Corporation, Austin, Texas (July 27, 1999)

18. **Methyl pivalate** - Exxon Chemical Company, Houston, TX (November 22, 1999)

19. **3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-(trifluoromethyl) hexane (also known as HFE-7500 or L-15381)** - 3M Corporation, St. Paul, MN. (August 21, 2000). ***[Proposed September 3, 2003, see 68 FR 52373]***

20. **Methyl Formate** - Foam Supplies, Inc., Earth City, Missouri (February 12, 2002) ***[Proposed September 3, 2003, see 68 FR 52373]***

The complete federal definition and the list of exempted compounds to date are shown on the following page.

40 CFR Part 51 Section 51.100 Definitions.

(s) Volatile organic compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.

(1) This includes any such organic compound other than the following, which have been determined to have negligible photochemical reactivity:

methane;	[74-82-8]
ethane;	[74-84-0]
methylene chloride (dichloromethane);	[75-09-2]
1,1,1-trichloroethane (methyl chloroform);	[71-55-6]
1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113);	[76-13-1]
trichlorofluoromethane (CFC-11);	[75-69-4]
dichlorodifluoromethane (CFC-12);	[75-71-8]
chlorodifluoromethane (HCFC-22);	[75-45-6]
trifluoromethane (HFC-23);	[75-46-7]
1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114);	[76-14-2]
chloropentafluoroethane (CFC-115);	[76-15-3]
1,1,1-trifluoro-2,2-dichloroethane (HCFC-123);	[306-83-2]
1,1,1,2-tetrafluoroethane (HFC-134a);	[811-97-2]
1,1-dichloro-1-fluoroethane (HCFC-141b);	[1717-00-6]
1-chloro-1,1-difluoroethane (HCFC-142b);	[75-68-3]
2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124);	[2837-89-0]
pentafluoroethane (HFC-125);	[354-33-6]
1,1,2,2-tetrafluoroethane (HFC-134);	[359-35-3]
1,1,1-trifluoroethane (HFC-143a);	[420-46-2]
1,1-difluoroethane (HFC-152a);	[75-37-6]
parachlorobenzotrifluoride (PCBTF);	[98-56-6]
cyclic, branched, or linear completely methylated siloxanes;	[various]
acetone;	[67-64-1]
perchloroethylene (tetrachloroethylene);	[127-18-4]
3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca);	[422-56-0]
1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb);	[507-55-1]
1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC-43-10mee);	[138495-42-8]
difluoromethane (HFC-32);	[75-10-5]
ethylfluoride (HFC-161);	[353-36-6]
1,1,1,3,3,3-hexafluoropropane (HFC-236fa);	[690-39-1]
1,1,2,2,3-pentafluoropropane (HFC-245ca);	[679-86-7]
1,1,2,3,3-pentafluoropropane (HFC-245ea);	[24270-66-4]
1,1,1,2,3-pentafluoropropane (HFC-245eb);	[431-31-2]
1,1,1,3,3-pentafluoropropane (HFC-245fa);	[460-73-1]
1,1,1,2,3,3-hexafluoropropane (HFC-236ea);	[431-63-0]
1,1,1,3,3-pentafluorobutane (HFC-365mfc);	[406-58-6]
chlorofluoromethane (HCFC-31);	[593-70-4]
1-chloro-1-fluoroethane (HCFC-151a);	[1615-75-4]
1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a);	[354-23-4]
1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$);	[163702-07-6]
2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OCH_3$);	[163702-08-7]
1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane ($C_4F_9OC_2H_5$);	[163702-05-4]
2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OC_2H_5$);	[163702-06-5]
methyl acetate	[79-20-9]
and perfluorocarbon compounds which fall into these classes:	[various]

(i) Cyclic, branched, or linear, completely fluorinated alkanes;
(ii) Cyclic, branched, or linear, completely fluorinated ethers with no unsaturations;
(iii) Cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations; and
(iv) Sulfur containing perfluorocarbons with no unsaturations and with sulfur bonds only to carbon and fluorine.

(2) For purposes of determining compliance with emissions limits, VOC will be measured by the test methods in the approved State implementation plan (SIP) or 40 CFR Part 60, Appendix A, as applicable. Where such a method also

measures compounds with negligible photochemical reactivity, these negligibly-reactive compounds may be excluded as VOC if the amount of such compounds is accurately quantified, and such exclusion is approved by the enforcement authority.

(3) As a precondition to excluding these compounds as VOC or at any time thereafter, the enforcement authority may require an owner or operator to provide monitoring or testing methods and results demonstrating, to the satisfaction of the enforcement authority, the amount of negligibly-reactive compounds in the source's emissions.

(4) For purposes of Federal enforcement for a specific source, the EPA shall use the test methods specified in the applicable EPA-approved SIP, in a permit issued pursuant to a program approved or promulgated under Title V of the Act, or under 40 CFR Part 51, Subpart I or Appendix S, or under 40 CFR Parts 52 or 60. The EPA shall not be bound by any State determination as to appropriate methods for testing or monitoring negligibly-reactive compounds if such determination is not reflected in any of the above provisions.

- NOTE: Chemical Abstract Service (CAS) identification numbers have been included in brackets [ ] after the compounds for convenience.

2. California Air Resources Board's Definition of ROG (Reactive Organic Gases):

The California Air Resources Board's (ARB's) Emission Inventory Branch (EIB) uses the terms Total Organic Gases (TOG) and Reactive Organic Gases (ROG). California air pollution control districts report Total Organic Gases (TOG) to the Air Resources Board's emission inventory.

For each source category, the ARB derives a value for the Reactive Organic Gases (ROG) by multiplying the reported TOG by the Fraction of Reactive Organic Gases (FROG). Each source category is keyed to one of several hundred available chemical speciation profiles. For each category, the FROG value is calculated as the weight fraction of those species designated by the ARB as reactive in the speciation profile applicable to the category. The ARB's organic gas speciation profiles are available for download from the ARB's web site at http://www.arb.ca.gov or specifically at http://www.arb.ca.gov/ei/speciate/speciate.htm.

The relationships among these organic gas terms are summarized as follows:

TOG (Total Organic Gas)	-	**Exempt cmpds** [ARB list of methane, CFCs, etc.]	=	**ROG** (Reactive Organic Gas)
TOG (Total Organic Gas)	x	**FROG** (Fraction of Reactive Organic Gas)	=	**ROG** (Reactive Organic Gas)

Background Regarding Federal vs. State Exempt List: The original "Air Pollution Emission Inventory Program" manual, ARB, March 1982, listed the compounds which the ARB initially treated as exempted from ROG. The list differed somewhat from the U.S. EPA's list of exempted VOCs even at the time, in that ARB's definition of ROG did not exempt Ethane. As discussed in the prior section, U.S. EPA later exempted additional compounds from the federal definition of VOC as well.

Subsequently, the Air Resources Board was petitioned regarding exemptions from the ARB's regulations. The ARB staff formed a Reactive Organic Gas Technical Committee (ROGTC), made up of staff from the ARB's affected divisions and district representatives, to systematically evaluate the proposed exemption of these compounds. At a public hearing in September 1995, the Air Resources Board took action to revise the definition of "Volatile Organic Compounds" that is used in the consumer products regulations, based on the recommendations of the ROGTC. Methyl siloxanes were added to the list of exempted compounds, and parachlorobenzotrifluoride, acetone, and ethane were added to the list of exempted compounds with the qualifier that they are "low-reactive organic compounds which have been exempted by the U.S. EPA". Based on the ROGTC's analysis, the staff similarly modified the overall inventory definition of ROG to extend the Board's action on the consumer products regulation "VOC" definition to "ROG" for all inventory applications.

The Air Resources Board exempted Perchloroethylene from the definition of VOC in the consumer products regulations in November 1996. In response to industry petition, the Air Resources Board approved the exemption of Methyl acetate from the definition of VOC in the ARB's regulations for aerosol coatings, consumer products, and antiperspirants and deodorants at a public hearing on November 19, 1998.

As noted above, the ARB's list of compounds has two parts, including a second group of "low-reactive organic compounds which have been exempted by the U.S. EPA". This designation is used for compounds that are expected to have low, but not insignificant, ozone formation impacts in the near-term; however, their future new uses and emissions need to be tracked, and the exemption revisited, if necessary, to ensure there is no future degradation of air quality resulting from increased usage.

Likewise, some compounds that have been exempted from the definition of ROG or VOC may have other adverse impacts, such as toxicity, stratospheric ozone depletion potential, or greenhouse gas potential, that must be considered. Therefore, "exemption" from the definition of ROG or VOC is not an automatic endorsement for increased usage of a compound.

The complete definitions and the list of exempted compounds to date are shown on the following page

ARB's Definitions of TOG and ROG (as of September 2004):

Total Organic Gases (TOG) means compounds of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate.

Reactive Organic Gases (ROG) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, and excluding the following:

		CAS *	(TAC) **
(1)	methane;	[74-82-8]	
	methylene chloride (dichloromethane);	[75-09-2]	TAC
	1,1,1-trichloroethane (methyl chloroform);	[71-55-6]	TAC
	trichlorofluoromethane (CFC-11);	[75-69-4]	
	dichlorodifluoromethane (CFC-12);	[75-71-8]	
	1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113);	[76-13-1]	
	1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114);	[76-14-2]	
	chloropentafluoroethane (CFC-115);	[76-15-3]	
	chlorodifluoromethane (HCFC-22);	[75-45-6]	
	1,1,1-trifluoro-2,2-dichloroethane (HCFC-123);	[306-83-2]	
	2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124);	[2837-89-0]	
	1,1-dichloro-1-fluoroethane (HCFC-141b);	[1717-00-6]	
	1-chloro-1,1-difluoroethane (HCFC-142b);	[75-68-3]	
	trifluoromethane (HFC-23);	[75-46-7]	
	pentafluoroethane (HFC-125);	[354-33-6]	
	1,1,2,2-tetrafluoroethane (HFC-134);	[359-35-3]	
	1,1,1,2-tetrafluoroethane (HFC-134a);	[811-97-2]	
	1,1,1-trifluoroethane (HFC-143a);	[420-46-2]	
	1,1-difluoroethane (HFC-152a);	[75-37-6]	
	cyclic, branched, or linear completely methylated siloxanes;	[various]	
	the following classes of perfluorocarbons:	[various]	
	(A) cyclic, branched, or linear, completely fluorinated alkanes;		
	(B) cyclic, branched, or linear, completely fluorinated ethers with no unsaturations;		
	(C) cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations; and		
	(D) sulfur-containing perfluorocarbons with no unsaturations and with the sulfur bonds only to carbon and fluorine; and		
(2)	the following low-reactive organic compounds which have been exempted by the U.S. EPA:		
	acetone;	[67-64-1]	
	ethane;	[74-84-0]	
	methyl acetate;	[79-20-9]	
	perchloroethylene; and	[127-18-4]	TAC
	parachlorobenzotrifluoride (1-chloro-4-trifluoromethyl benzene).	[98-56-6]	

---

* NOTE: Chemical Abstract Service (CAS) identification numbers have been included in brackets [ ] for convenience.

** NOTE: "TAC" indicates compounds that have been identified by the ARB as Toxic Air Contaminants (TAC). Their "exemption" from the definition of ROG or VOC is not an endorsement for their increased usage.

Prepared September 2004 by Beth Schwenr, California Air Resources Board, Planning and Technical Support Division, Emission Inventory Branch, bschwehr@arb.ca.gov.

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7525: CPVC 1-STEP CEMENT 8 OZ.

MSDS Last updated: 01/04/1999

MSDS SHEET FOR CPVC 1-STEP CEMENT 8 OZ. #7525

*** SECTION 1 PRODUCT IDENTIFICATION ***

Manufacturer's Name:	Oatey Corp.
Manufacturer's Address:	4700 W. 160th Street P.O. Box 35906 Cleveland, Ohio 44135
Emergency Telephone:	(303) 623-5716 Collect
Distributor's Name:	Imperial Supplies LLC
Distributor's Address:	789 Packer Drive Green Bay, WI 54304
Information Telephone:	(800) 558-2808
Product Name:	CPVC 1-STEP CEMENT 8 OZ.
Imperial No.:	7525
Manufacturer No.:	31911

*** SECTION 2 HAZARDOUS INGREDIENTS ***

Ingredients	%	Cas #	Sec 313
Tetrahydrofuran (See Section 6)	40-50	109-99-9	No
Acetone	24-34	67-64-1	No
Cyclohexanone	5-10	108-94-1	No
Methyl Ethyl Ketone	<5	78-93-3	Yes
Non-Hazardous Ingredients			
CPVC Resin	13-16	68648-32-8	No
Amorphous Silica	.25-3	112945-52-5	No
Proprietary	5-25		No

*** SECTION 3 HAZARDS IDENTIFICATION ***

Hazards	Yes	No	Hazards	Yes	No
Combustible Liquid		X	Skin Hazard	X	
Flammable Liquid	X		Eye Hazard	X	
Pyrophoric Material		X	Toxic Agent	X	
Explosive Material		X	Highly Toxic Agent		X
Unstable Material		X	Sensitizer		X
Water Reactive Material		X	Kidney Toxin	X	
Oxidizer		X	Reproductive Toxin	X	
Organic Peroxide		X	Blood Toxin		X
Corrosice Material		X	Nervous System Toxin	X	
Compressed Gas		X	Lung Toxin	X	
Irritant	X		Liver Toxin	X	
Carcinogen NTP/IARC/OSHA		X			

*** SECTION 4 REGULATIONS ***

Chemical:	Tetrahydrofuran	Acetone
TLV (TWA):	200 ppm, 590 mg/cu m	750 ppm, 1800 mg/cu m
PEL (Transitional Limits):	200 ppm, 590 mg/cu m	1000 ppm, 2400 mg/cu m
STEL:	250 ppm, 735 mg/cu m	1000 ppm, 2400 mg/cu m
Hazard Action Level:	N/A	N/A

Chemical:	Cyclohexanone	Methyl Etheyl Ketone
TLV (TWA):	25 ppm, 100 mg/cu m(skin)	200 ppm, 590 mg/cu m
PEL (Transitional Limits):	50 ppm, 200 mg/cu m	200 ppm, 590 mg/cu m
STEL:	100 ppm, 400 mg/cu m	300 ppm, 885 mg/cu m
Hazard Action Level:	N/A	N/A

Chemical:	Amorphous Silica
TLV (TWA):	10 mg/cu m
PEL (Transitional Limits):	20 mppcf
STEL:	N/A
Hazard Action Level:	N/A

*** SECTION 5 REGULATED IDENTIFICATION ***

DOT Proper Shipping Name:	Consumer Commodity ORM-D
DOT Hazard Class:	N/A
Shipping ID No.:	N/A
EPA Hazardous Waste ID No.:	D-001
EPA Hazard Waste Class:	Ignitable Waste

*** SECTION 6 EFFECTS OF EXPOSURE ***

Entry Route: Inhale- Yes Ingest- Yes Skin- Yes Eye- Yes

Inhalation: May cause irritation of mucous membranes, nose & throat, headache, dizziness, nausea, numbness of the extremities and narcosis in high concentrations. Has caused CNS depression & liver damage in animals, & high concentrations have caused retardation of fetal development in rats.

Tetrahydrofuran Warning: The National Toxicology Program has reported that exposure of mice and rats to Tetrahydrofuran (THF) vapor levels up to 1800 ppm 6 hr/day, 5 days/week for their lifetime caused an increased incidence of kidney tumors in male rats and liver tumors in female mice. The significance of these findings for human health are unclear at this time, and may be related to "species specific" effects. Elevated incidences of tumors in humans have not been reported for THF. THF is not listed as a carcinogen by NTP, IARC, or OSHA. One THF vendor has recommended a reduction in the "acceptable exposure limit" from 200 ppm to 25 ppm, 8 and 12 hour time weighted average.

Skin: Chronic contact may lead to irritation & dermatitis. Chronic exposure to vapors of high concentration may cause dermatitis. May possibly be absorbed through the skin.

Eye: Vapors or direct contact may cause irritation.

Ingestion: May be aspirated into the lungs or cause systemic effects described under inhalation.

Target Organs: Eye, Skin, Kidney, Lung, Liver, Central Nervous System

*** SECTION 7 FIRST AID MEASURES- (303)623-5716 COLLECT ***

Skin: If irritation arises, wash thoroughly with soap and water. Seek medical attention if irritation persists.

Eyes: If fumes cause irritation, move to fresh air and irrigate eyes with water for 15 minutes. If irritation persists, seek medical attention.

Inhalation: Move to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Keep victim quiet and warm. Call a poison control center or physician immediately.

Ingestion: Drink water and call a poison control center or physician immediately. Avoid alcoholic beverages. Never give anything by mouth to an unconscious person.

*** SECTION 8 PHYSICAL & CHEMICAL PROPERTIES ***

NFPA Hazard Signal:	Health 2 Stability 1 Flammability 3 Special None
Boiling Point:	151 Degrees F / 66 C
Melting Point:	N/A
Vapor Pressure:	145 mmHg @ 20 Degrees C

Vapor Density (Air=1):	2.5
Volatile Components:	70-80% WT.
Solubility in Water:	Negligible
PH:	N/A
Specific Gravity:	0.91 plus/minus 0.02
Evaporation Rate:	(BUAC=1) = 5.5-8.0
Appearance:	Gold Liquid
Odor:	Ether-Like
Will Dissolve In:	Tetrahydrofuran
Material Is:	Liquid

*** SECTION 9 FIRE & EXPLOSION HAZARD DATA ***

Flammability:	LEL=1.8 %Volume UEL=11.8 %Volume
Flashpoint & Method Used:	5-8 Degrees F. / PMCC
Stability:	Stable Conditions To Avoid: Heat, sparks and open flame. Hazardous Decomp. PDTS.: Carbon Monoxide / Carbon Dioxide / Hydrogen Chloride / Smoke.
Hazardous Polymerization:	Will Not Occur. Conditions To Avoid: None
Incompatibility/Mat. To Avoid:	Acids, oxidizing materials, alkalis, chlorinated inorganics (potassium, calcium and sodium hypochlorite), copper or copper alloys.
Special Fire Fighting Procedure:	For Small Fires: Use dry chemical, CO2, water or foam extinguisher. For Large Fires: Evacuate area and call Fire Department immediately.

*** SECTION 10 SPILL & DISPOSAL INFORMATION ***

Spill or Leak Procedures:	Ventilate area, stop leak if it can be done without risk. Take up with sand, earth, or other non-combustible absorbing material.
Waste Disposal:	Dispose of according to local, state, and Federal regulations.

*** SECTION 11 SAFE USAGE DATA ***

Protective Equipment Types:	Eyes: Safety glasses with side shields. Respiratory: NIOSH-approved cannister respirator in absence of adequate ventilation. Gloves: Rubber gloves. Other: Eye wash and safety shower should be available.
Ventilation:	General Mechanical: Exhaust ventilation capable of maintaining emissions at the point of use below PEL. Local Exhaust: Open doors & windows. If used in enclosed area, use exhaust fans.
Precautions:	Handling & Storage: Keep away from heat, sparks and flames; store in cool, dry place. Other: Containers, even empties will retain residue and vapors.

*** SECTION 12 DISCLAIMER ***

The information herein has been compiled from sources believed to be reliable, up-to-date, and is accurate to the best of our knowledge. However, Oatey cannot give any guarantees regarding information from other sources, and expressly does not make warranties, nor assumes any liability for its use.

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Questions or comments? Contact us.

Bill Staack

From: Bill Staack
Sent: Monday, January 12, 2004 10:31 AM
To: Dave Walls; Doug Hensel; Kevin Reinertson
Subject: FW: Drinking water data from households.

FYI. From OEHHA. Office of Environmental Health and Hazard Assessment of CalEPA.

-----Original Message-----
From: Bob Howd [mailto:BHOWD@oehha.ca.gov]
Sent: Monday, January 12, 2004 10:01 AM
To: Bill Staack
Cc: Anna Fan
Subject: Re: Drinking water data from households.

We have no information on potential water contaminants from the two plastic pipe materials you mention. However, we are in the midst of a reassessment of copper for development of a public health goal (PHG) for copper in drinking water. The current PHG of 0.17 mg/L, set by our office in 1997, was based on acute gastrointestinal effects in children. Such effects have been confirmed in subsequent studies in both infants and adults, with No Observed Effect Levels of 2 mg/L or less. It seems to me that a target level of copper in drinking water, measured at the tap, should be in the range of 0.1 to 0.3 mg/L, i.e., at about the level of the PHG. Our literature search has identified the recent studies and reports listed below as relevant to the reevaluation of copper toxicity.

California has an extensive database of concentrations of chemicals detected in drinking water, which is available from the California Department of Health Services on a CD. Information on this can be obtained from Anthony Meeks of the DHS Monitoring and Evaluation Unit (Drinking Water Program, Department of Health Services, 1616 Capitol Avenue, MS 7418, Sacramento, CA 95814), or at (916) 449-5568 or ameeks@dhs.ca.gov.

not tap water samples

REFERENCES

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(510) 622-3168

The opinions expressed above are my own. They have not been reviewed or approved by any higher authority, and should not be interpreted as representing an official OEHHA or Cal/EPA position.

>>> Anna Fan 01/09/04 04:19PM >>>
Hi, Bill,

Thank you for your inquiry. You are working on very interesting topics.

I think the most efficient way to respond is for me to refer you to Dr. Bob Howd. His e-mail is bhowd@oehha.ca.gov. He can give you info that he may have and direct you to other sources that would be helpful to you.

If I can be of further assistance, pl let me know.

Anna

>>> "Bill Staack" <BStaack@hcd.ca.gov> 01/09/04 03:38PM >>>
Anna.

My Department has been doing some literature searches on three different potable water pipe materials allowed for use in residential building. CPVC (chlorinated polyvinyl chloride), PEX (cross-linked polyethylene) and copper. I have not found many studies on the two plastic pipe materials that would suggest significant health effects. However, I have found a lot of literature concerning copper leaching from pipes and the potential health issues concerning ingestion (especially potential long term chronic affects) of copper from water pipe. I have your Departments December 1997 document on "Public Health Goal for Copper in Drinking Water" and some studies that I have summarized below.

Does your agency have any test data on household water especially first drawn water for copper concentrations? Or know who may have such data on copper concentrations from California homes?

Also, does your agency have any studies on the materials used for the two plastic pipes discussed above: CPVC and PEX?

Doug Hensel

From: Bill Staack
Sent: Monday, January 12, 2004 11:15 AM
To: Dave Walls; Doug Hensel; Kevin Reinertson
Subject: FW: Drinking water data from households.

FYI from OEHHA

-----Original Message-----
From: Bob Howd [mailto:BHOWD@oehha.ca.gov]
Sent: Monday, January 12, 2004 11:12 AM
To: Bill Staack
Cc: Anna Fan; Moira Sullivan
Subject: RE: Drinking water data from households.

The literature on Wilson's disease, and other forms of copper sensitivity, is part of our review for the PHG revision. The studies on clioquinol interaction with the plaques formed in Alzheimer's disease are certainly interesting, but would not necessarily be cited in our PHG document, since this is still somewhat peripheral to defining a safe level of copper in drinking water. Because copper is involved in assembly of some structural proteins in neural tissues (copper deficiencies cause myelin disorders somewhat similar to the pathology caused by clioquinol - although much more severe in the case of Menke's disease), it's not surprising that binding copper with clioquinoline antibiotics would counteract the adverse assembly of structural proteins observed in some models of Alzheimer's disease.

Good evidence that excess copper might also be associated with the development of Alzheimer's disease or other neurological disorders (except for Wilson's disease) is just not available - although this is the sort of thing that we're very interested in keeping up with in our data reviews. Thanks for bringing this to our attention.

Robert A. Howd, Ph.D., Chief, Water Toxicology Unit
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>>> "Bill Staack" <BStaack@hcd.ca.gov> 01/12/04 10:25AM >>>
Thank you Bob. Has your Department looked into the sensitivity in the human populations chronic copper toxicity in the liver and neurological toxicity with those with Wilson and Menke's disease?

I also saw some interesting independent studies suggesting ingested copper having a potential association with Attention-Deficit/Hyperactivity Disorder (ADHA), Autism Disorder, and Alzheimer's disease (amaloid plaques). Has your Department looked into any of these potential chronic affects of copper ingestion?

One such study discussed the use of an Clioquinoline an antibiotic approved as a human drug decades ago and is now being tested on 50 Alzheimer's patients, said Dr. Ashley Bush of Massachusetts General Hospital and Harvard Medical School. The antibiotic is being tested to determine if the effects of Alzheimer's disease can be reduced by the elimination of some or all protein deposits plaques. (Copper and zinc "decorate" those plaques that are a major feature of the disease, a researcher says.)

-----Original Message-----
From: Bob Howd [mailto:BHOWD@oehha.ca.gov]
Sent: Monday, January 12, 2004 10:01 AM
To: Bill Staack
Cc: Anna Fan
Subject: Re: Drinking water data from households.

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>>> Anna Fan 01/09/04 04:19PM >>>
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If I can be of further assistance, pl let me know.

Anna

>>> "Bill Staack" <BStaack@hcd.ca.gov> 01/09/04 03:38PM >>>
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Does your agency have any test data on household water especially first drawn water for copper concentrations? Or know who may have such data on copper concentrations from California homes?

Also, does your agency have any studies on the materials used for the two plastic pipes discussed above: CPVC and PEX?

I received a report concerning copper leaching from pipes above federal health levels in the City of Murrieta, CA at the Murrieta Ranchos Development done by Associates Laboratories done July 17 thru July 25, 2002.

Some of the studies/reports discussed findings from independent scientific studies, a nationwide study from the National Research Council (NRC) studying U.S. EPA's health level for copper in drinking water published in 2000, and an international study "International Programme of Chemical Safety" on copper in drinking water.

Much of the literature found on the web discussed the various health issues listed and discussed below. If you have any current studies that may address any of these issues we would appreciate either copies of, or citations to, those studies.

- Cardiovascular or Blood Toxicant
- Newborn Exposure Toxicant
- Developmental Toxicant
- Gastrointestinal or Liver Toxicant
- Kidney Toxicant
- Reproductive Toxicant
- Defective copper homoeostatic Toxicant
- Potential link to Attention-Deficit/Hyperactivity Disorder (ADHA), Autism Disorder, and Alzheimer's disease

Some of the findings and recommendation from the literature search included:

1. The NRC stated that the current health level established by U.S. EPA for Cu is for acute exposure and is not suitable for establishing a health base level for MCLG (maximum contaminant level goal). The need to develop a chronic exposure level is necessary and will be at a lower concentration.
2. The National Research Defense Counsel cited a study (Sidhu, K 1995) in its report that recommended decreasing the federal maximum allowed amount of Cu in drinking water in order to adequately protect children.
3. The NRC reported that in sensitive human populations, the majority target of chronic Cu toxicity is the liver and neurological toxicity with those with Wilson and Menke's disease (1-2% of population).

4. The NRC stated that infants fed formula with tap water are much more sensitive to elevated copper in water because they have a higher absorption rate and educed capacity to excrete copper as those of an older age.

5. The NRC stated that evidence suggests that when the bodies ability to regulate Cu is surpassed by excess Cu, a large amount of Cu is released into the bloodstream damaging red blood cells and causing acute hemolytic anemia. The NRC recommended that increased in the ingestion of Cu should be cautioned against until the hepatic (liver) susceptibility is clearly identified.

7. A Wisconsin Department of Health and Social Service's Division of Health study stated that "first flush" drinking water in Cu pipes often contain Cu levels that exceed federal drinking water standards and should be flushed prior to drinking.

8. Some independent studies suggested ingested copper may have a potential association with Attention-Deficit/Hyperactivity Disorder (ADHA), Autism Disorder, and Alzheimer's disease (amaloid plaques).

Bill Staack, Esq., P.E.
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Dave Walls

From: Bill Staack
Sent: Wednesday, January 21, 2004 10:14 AM
To: Harry Moos
Cc: Dave Walls
Subject: Statement from Rulemaking Package for CPVC Adoption

Harry. FYI. Below is a statement used in the Initial Statement of Reasons of the Rulemaking Package when HCD adopted the limited use of CPVC. I thought it may be of some use in your effort to propose the statewide adoption of CPVC in Californian.

"Requirements of Mitigated Negative Declaration: As noted above, a Mitigated Negative Declaration was adopted by HCD on November 8, 2000. The Mitigated Negative Declaration found that given the limited scope of the project, and/or provided the proposed mitigation measures were complied with, the implementation of the building standard would not result in any significant environmental impacts or potential health hazards to the homeowner or installer of the CPVC pipe. As part of HCD's adoption of the Mitigated Negative Declaration, the adopted building standard must include the mitigation measures discussed in the Mitigated Negative Declaration."

Bill Staack, Esq., P.E.
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Guide to Public Health Goals (PHGs) for Chemicals in Drinking Water

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency
October 2003

This guide explains how Public Health Goals (PHGs) developed by the Office of Environmental Health Hazard Assessment (OEHHA) help to maintain the quality of California's drinking water supplies.

Contaminants in Drinking Water

California's regulatory drinking water standards protect the public from harmful substances, but no water supply is ever completely free of contaminants. Some, such as arsenic and uranium, can occur naturally. Others, such as fuels, industrial solvents, pesticides and metals, may enter water supplies from chemical spills and leaking tanks and pipelines, or they may be a legacy of agricultural and waste-disposal practices that predated modern environmental laws.

It is natural for people to want their drinking water to be completely free of all contaminants. However, preventing or removing all contamination often is not economically or technologically feasible. State health authorities are responsible for determining the levels of contaminants that, based on current laws and recommendations, can remain in water supplies without threatening human health.

Public Health Goals and Drinking Water Standards

To keep drinking water safe, the California Legislature passed the Calderon-Sher Safe Drinking Water Act of 1996. This law requires the Department of Health Services (DHS) to regularly test drinking water supplies and set standards for contaminants in the water. The Act also requires OEHHA to develop Public Health Goals (PHGs) for contaminants in California's publicly supplied drinking water.

PHGs Set at Levels That Protect Human Health

For carcinogens, OEHHA establishes the PHG at the "one-in-one-million" risk level. At that level, not more than one person in a population of one million people drinking the water daily for 70 years would be expected to develop cancer as a result of exposure to that chemical.

For chemicals that cause health effects other than cancer, OEHHA sets the PHG at a level that is not expected to cause any toxic effects, including birth defects and chronic illness.

What Is a Public Health Goal?

A PHG is the level of a chemical contaminant in drinking water that does not pose a significant risk to health. PHGs are not regulatory standards; however, state law requires DHS to set drinking water standards for chemical contaminants as close to the corresponding PHG as is economically and technically feasible.

In some cases, it may not be feasible for DHS to set the drinking water standard for a contaminant at the same level as the PHG. The technology to treat the chemicals may not be available, or the cost of treatment may be very high. DHS must consider these factors when developing a drinking water standard.

How Does OEHHA Establish a Public Health Goal?

The process for establishing a PHG for a chemical contaminant in drinking water is very rigorous. OEHHA scientists first compile all relevant scientific information available, which includes studies of the chemical's effect on laboratory animals and studies of humans who have been exposed to the chemical. The scientists use data from these studies to perform a *health*

risk assessment, in which they determine the levels of the contaminant in drinking water that could be associated with various adverse health effects. (For more information on health risk assessments, please see "A Guide to Health Risk Assessment," on OEHHA's Web site at www.oehha.ca.gov.) In performing the health risk assessment, OEHHA considers the following factors:

- Certain groups of people, such as pregnant women, young children, the elderly or persons with pre-existing illnesses, who may be especially susceptible to the chemical's adverse effects. The PHG must consider health effects on individuals in these groups.
- Accumulated effects of exposure to the chemical from other sources, such as food, air and soil, and other uses of drinking water, such as showering.
- The chemical's potential to interfere with bodily functions in a way that increases the risk of chronic health problems, such as liver damage.
- Possible synergistic effects from the combined exposure to the chemical in question and other chemicals, which may further increase health risks.

When calculating a PHG, OEHHA uses all the information it has compiled to identify the level of the chemical in drinking water that would not cause significant adverse health effects in people who drink that water every day for 70 years. OEHHA assumes that an adult will drink two liters of water per day and a child will drink one liter per day. OEHHA must also consider any evidence of immediate and severe health effects when setting the PHG.

OEHHA establishes the PHG at a level that provides protection against any known cancer and "noncancer" health effects associated with exposure to the chemical in question. For cancer-causing chemicals, OEHHA typically establishes the PHG at the "one-in-one million" risk level. At that level, not more than one person in a population of one million people drinking the water daily for 70 years would be expected to develop cancer as a result of exposure to that chemical. The "one-in-one million" risk level is widely accepted in the medical and scientific communities as the "negligible risk" standard.

For chemicals that do not cause cancer, OEHHA sets the PHG at a level that is not expected to cause any toxic effects, including birth defects and chronic illness. OEHHA reviews scientific studies of a chemical and identifies the lowest level of exposure to the chemical that caused no observed health effects in those studies. OEHHA then adds a "safety margin" to account for uncertainties and gaps in information on the chemical's toxicity. The PHG is commonly set at 100 to 3,000 times below the "no observable effect level," depending on the type of toxicity associated with the chemical, and the amount of scientific information available. OEHHA assumes people will drink the water daily for many years

OEHHA's Role in Protecting Water Quality

OEHHA is part of the California Environmental Protection Agency. Its professional staff includes toxicologists, epidemiologists, physicians, biostatisticians, and research scientists who are located in offices in Sacramento and Oakland. OEHHA is responsible for assessing health risks posed to the public by hazardous chemicals and provides its scientific expertise in this area to other state regulatory agencies. Through its risk assessments and its development of Public Health Goals (PHGs), OEHHA assists the Department of Health Services in developing regulatory standards for chemicals in the state's drinking water.

when developing a PHG to protect against noncancer health effects. This assumption of lifelong exposure to a contaminant is a standard practice in risk assessment.

Many drinking water contaminants are associated with both cancer and noncancer health effects. In those cases, OEHHA will determine the two levels that adequately protect against cancer and noncancer health effects, and then set the PHG at the lower of the two levels. This helps ensure the PHG is set at a health-protective level.

Who Keeps Drinking Water Safe?

U.S. Environmental Protection Agency (U.S. EPA) sets national drinking water standards and grants authority to each state to administer its own drinking water program.

California Department of Health Services (DHS) is the regulatory agency with the authority to set and enforce drinking water standards for the state. It may maintain standards at levels set by U.S. EPA, or it may set more stringent standards. Through its Drinking Water Program, the department works with **county health departments** to license and monitor public water systems and set standards for privately owned wells.

California Environmental Protection Agency (Cal/EPA) includes the **Office of Environmental Health Hazard Assessment**, the **State Water Resources Control Board** and nine **Regional Water Quality Control Boards**. The water boards evaluate the quality of the state's surface water and groundwater, and regulate the storage and discharge of materials and pollutants that affect water quality. OEHHA develops Public Health Goals for drinking water.

Local governments may oversee commercial, private or agricultural use of land affecting water quality.

Public water systems have the ultimate responsibility for keeping water safe. Any system that serves more than 25 people or 15 service connections must regularly test its water supplies and meet state and federal regulatory standards.

After developing a draft PHG, OEHHA posts the document on its Web site (www.oehha.ca.gov/water/phg/index.html) and holds a public-review period and at least one public workshop to solicit comments from interested parties. The draft document is also reviewed by one or more independent scientists from the University of California or another academic institution, as well as the U.S. Environmental Protection Agency. OEHHA considers these comments before determining the final PHG.

Final PHG documents are posted on OEHHA's Web site. OEHHA is mandated by law to review a published PHG at least every five years and revise it, as necessary, based on any new scientific data. OEHHA maintains an updated list of PHGs on its Web site at (www.oehha.ca.gov/water/phg/allphgs.html).

How Are Public Health Goals Used to Set Regulatory Standards for Chemicals in Drinking Water?

PHGs are necessary guides for making decisions about the levels of chemical contaminants in drinking water, but these guidance levels are just one element that DHS must consider when maintaining the quality of drinking water. By law, DHS must set the state's regulatory standards, known as *Primary Maximum Contaminant Levels* (MCLs), as close as possible to the PHG levels that OEHHA establishes. However, DHS must also consider the cost and technical feasibility of treating or preventing chemical contamination.

The Calderon-Sher Safe Drinking Water Act requires OEHHA to develop a PHG for each drinking water contaminant that is regulated with an MCL. OEHHA must also develop a

PHG before DHS can establish an MCL for a contaminant for the first time. DHS must review a primary MCL at least every five years and amend it, if necessary, to make it as close to the corresponding PHG as is feasible. DHS could amend an MCL if the PHG evaluation indicates that the contaminant is more or less toxic than was previously believed, or if new technology is available to reduce concentrations to levels closer to the PHG.

Is Water Safe to Drink if Contaminant Levels Exceed Public Health Goals?

As long as drinking water complies with all MCLs, it is considered safe to drink, even if some contaminants exceed PHG levels. A PHG represents a health-protective level for a contaminant that DHS and California's public water systems should strive to achieve *if* it is feasible to do so. However, a PHG is *not* a boundary line between a "safe" and "dangerous" level of a contaminant, and drinking water can still be considered acceptable for public consumption even if it contains contaminants at levels exceeding the PHG.

For example, suppose the actual level of a contaminant in many drinking water sources were high enough to pose a "ten-in-one million" cancer risk. (At that level, not more than ten cancer cases would be expected in a population of one million people as a result of drinking water containing that level of the contaminant daily for 70 years.) As explained on page 3, OEHHA typically establishes the PHG for cancer-causing contaminants at the "one-in-one million" risk level. However, a "ten-in-one million" risk is widely considered by health and scientific authorities to be acceptable as long as it is not feasible to further reduce the risk. State law would allow DHS to set the MCL for the contaminant at the level posing a "ten–in-one million" risk of cancer if it were not feasible to set the standard at a lower level. In this case, levels of the chemical exceeding the PHG and below the MCL would be considered acceptable for protection of public health.

Even if a PHG is not immediately achievable, it still represents an important long-term goal for California drinking water. The PHG helps give researchers an incentive to develop new or improved cost-effective water-treatment technologies that can feasibly reduce contaminants to PHG levels.

How Can the Public Learn More About Contaminants in the Water?

California law requires that public water systems inform consumers about the quality of their drinking water through the following reports:

Annual Consumer Confidence Reports

Public water systems are required to send each customer an annual consumer confidence report that describes the source of the water supply and any contaminants detected in it. The report must list the current level of a contaminant as well as its PHG and primary MCL. The report must also disclose if an MCL was exceeded and include a plainly worded statement of associated health concerns.

Exceedance Reports

Water systems with more than 10,000 service connections by law must prepare an exceedance report every three years if one or more chemical contaminants exceed PHG levels. The report provides information on health risks posed by the contaminants as well as the costs and technology needed to reduce the contaminants to the PHG level. The report must also explain

what action, if any, the local water supplier has planned to address the contamination. The water supplier must hold a public hearing on the report.

Other Notification Requirements

When a contaminant in a public drinking water source exceeds the primary MCL, the water supplier must notify its customers in accordance with DHS requirements. In instances where there is an imminent threat to human health, the water supplier would have to provide immediate notice to customers. The law requires DHS to approve the content of such notices.

Sources of Additional Information

Office of Environmental Health Hazard Assessment
OEHHA's Web site (www.oehha.ca.gov) contains draft and final PHG documents, announcements of public workshops and comment periods on draft PHGs, copies of this fact sheet, and other fact sheets concerning health risk assessment, diesel exhaust, children's health and other topics. For more information, contact:

Office of Environmental Health Hazard Assessment
Pesticide and Environmental Toxicology Section
1001 I Street, P.O. Box 410
Sacramento, California 95812
(916) 324-7572

California Department of Health Services
The DHS Division of Drinking Water and Environmental Management posts information on PHGs and MCLs on its Web site. Contact:

Division of Drinking Water and Environmental Management
Department of Health Services
P.O. Box 942732
Sacramento, California 94234-7320
(916) 322-2308
www.dhs.ca.gov

Local Public Water System, County Health Department or County Environmental Health Department
The best source of information on contaminants in your local drinking water supply is usually the local water supplier. For contact information, check your water bill or call your city's public works department. If your source of drinking water is a private well, contact your county health or environmental health department for water quality standards and testing information.

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see California's official "Flex Your Power" Web site at www.flexyourpower.ca.gov.

From: Cynthia Oshita [COSHITA@oehha.ca.gov]

Sent: Monday, April 26, 2004 11:00 AM

To: Bill Staack

Subject: Re: Question.

Bill - I am by no means an expert on PHGs. They are the focus of the Pesticide and Environmental Toxicology Section (PETS) of OEHHA. I found a fact sheet on our web page that explains PHGs at http://www.oehha.ca.gov/water/phg/pdf/PHGfacts.pdf much better than I ever could. If you have other specific questions about PHGs you should either contact our deputy director for external affairs, Allan Hirsch at ahirsch@oehha.ca.gov or the PETS office directly. Dr. Anna Fan at afan@oehha.ca.gov is the chief of the section. The fact that the 4 solvents are not on the P65 list would mean that they are not subject to the warning requirement or discharge to sources of drinking water prohibition. We are continually considering chemicals for addition to the P65 list, but are not actively considering any of the 4 you mentioned. Chemicals on the list are identified as having sufficient evidence for causing cancer or reproductive toxicity — other adverse toxic effects are not considered under P65. Hope this helps...
Cindy

>>> "Bill Staack" <BStaack@hcd.ca.gov> 4/22/2004 2:05:49 PM >>>

Hi Cindy. Sorry or all my questions these days. I wonder exactly what a PHG is used for. I think I understand that your agency is suppose to develop these PHG and what the basis of these goals are in that the at the level provided there should be no health effects. If this is basically true, then how is a PHG used when it is compared with a measured concentration that is equal to the PHG, slightly above, or say a factor 20 times higher.

Also, I'm looking at 4 different solvents that I have not seen on the Prop 65 list or having PHG:

Tetrahydrofuran

Actone

Cyclohexanone

Methyl Ethyl Ketone

What does it mean when these chemicals are not on Prop 65 list of having PHG?

Sorry for all the questions.

Bill Staack, Esq., P.E.

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4/26/2004

Comments on the Draft Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings

Final Report

August 1998

Prepared by Peggy Lopipero, M.P.H. and Martyn T. Smith, Ph.D.

AUTHORS

Dr. Martyn T. Smith is currently employed as Professor of Toxicology in the School of Public Health at the University of California, Berkeley. He is also currently Head of the Division of Environmental Health Sciences. In 1994, he was elected a Fellow of the American Association for the Advancement of Science for his outstanding contributions to the field of environmental toxicology. He is a full member of the Society of Toxicology, The American Association for Cancer Research, the American Society of Hematology and numerous other professional societies. He has 150 publications in the scientific literature and has served as a consultant or grant reviewer to many institutions including various branches of the National Institutes of Health, U.S. Environmental Protection Agency, California Environmental Protection Agency, the UK Medical Research Council, and numerous law firms. He has provided expert testimony in litigation and has qualified as an expert in toxicology in courts in California, Colorado, and Pennsylvania.

Peggy Lopipero has a Masters of Public Health in Environmental Health Sciences (specialization in Toxicology and Epidemiology) from the School of Public Health at University of California, Berkeley. Since 1989, she has worked as a Consultant in Environmental/Occupational Health. Clients include the American Lung Association, California Environmental Protection Agency, Public Health Institute, South Coast Air Quality Management District, US Attorney General, University of California at Berkeley, University of California at San Francisco, the Swiss government, and numerous law firms.

INTRODUCTION

The purpose of this document is to present a critique of the adequacy, accuracy and completeness of the toxicological and epidemiological issues evaluated in the Draft Environmental Impact Report (draft EIR) for chlorinated polyvinyl chloride (CPVC) pipe use for potable water piping in residential buildings. After review of the draft EIR and the relevant literature, we find that the conclusion that use of CPVC pipe for potable water piping in residential buildings will not result in any significant adverse impacts on the environment is not supported by the analysis presented in the draft EIR or its technical appendix. We also find evaluation of the potential health effects to exposed workers and residents is deficient and at times inaccurate. Based on the analysis which follows, we find that significant adverse health effects on workers and drinking water consumers from the proposed CPVC approval would not be unexpected.

The following discussion presents our detailed evaluation of the draft EIR. The first section presents a general outline of some of the criticisms of the report. This is followed by a detailed discussion of the sections of the document pertaining to potential health effects and environmental impacts.

GENERAL OUTLINE OF COMMENTS

The draft EIR on CPVC pipe use for potable water is deficient in several toxicological aspects. In terms of general population health risks, the draft EIR has failed to consider:

- that the NSF standards on which its health risk comparison is based do not appear to be health protective
- the possibility of synergistic or additive effects between different chemicals in CPVC pipe leachate and/or common contaminants of tap water
- exposure from inhalation and dermal absorption
- the possible carcinogenicity of THF
- the potential toxic effects resulting from exposure to mono and diorganotins
- the lack of long term exposure data for MEK and acetone, and the potential developmental and reproductive effects of these substances

In terms of worker health issues, the draft EIR has failed to adequately consider:

- that the TLV's for worker exposure to THF, MEK, acetone and several other solvents may not be adequately health protective
- that combined dermal and inhalation exposure to CPVC cement solvents and primers may result in significant adverse short term and long term health effects
- the potential carcinogenicity of THF
- the lack of chronic toxicity data for MEK
- potential interactions of acetone, MEK, THF and solvent mixtures
- the fact that short term exposures to these solvents may produce chronic health effects
- a worst-case analysis analysis of worker exposure

With regards to the analysis of the effects of existing piping materials and their effect on the general population, workers, and the environment, the draft EIR does NOT provide data to substantiate the assertions that:

- exposure to copper pipe and steel pipe leachate would result in adverse health effects to drinking water consumers
- workers exposed to copper pipe solders and fluxes are in danger of adverse health effects
- the environmental impacts of copper pipe are greater than those resulting from CPVC pipe

Specific Comments

NSF Standards for CPVC Related Solvents and Organotins in Drinking Water

The draft EIR states that it has relied on Maximum Allowable Limits (MAL's) determined by the National Sanitary Foundation (NSF) for CPVC related solvents and organotins since such standards have not been established by the USEPA or the California Department of Health Services. The MAL's were said to be calculated using methodology as described in ANS/NSF 61 (1997) Appendix A which includes two sets of standards, Maximum Drinking Water Levels (MDWL's) and Short Term Exposure Levels (STEL's). It should be noted that the methodology for calculating the MAL's as described in this appendix does not account for multipathway exposures, additive or synergistic effects, or exposure of infants and children.

The NSF STEL's relied upon by the draft EIR are not adequately defined in the draft EIR nor in NSF61, Appendix A. Note that the American Conference of Governmental

Industrial Hygienists (ACGIH) defines a STEL as an airborne concentration of a substance that represents conditions under which it is believed that nearly all workers may be exposed for a short period of time (usually 15-minutes) without adverse affect (Klaassen, 1996). For purposes of our commentary, we assume that the STEL's refer to acute or subacute exposure. Nonetheless, it is not possible to conduct a complete and meaningful evaluation of the adequacy of the action levels without a more complete description (i.e., do the STEL's pertain to a 1-hour, 1-day, 1-week, several weeks exposure?).

In addition, the draft EIR must describe the underlying toxicological or epidemiological studies and data upon which each of the MAL's (MDWL's and STEL's) are based. Meaningful conclusions regarding the extent to which the NSF's MAL's protect public health cannot be made without this information. It is essential in this case that the NSF standards be fully described and the underlying scientific basis for those levels provided since we conclude based on even a brief review of the literature that six of the NSF values are too high to be adequately health-protective.

Before presenting our analyses, the following is a brief discussion of the scientific process and risk assessment methodology by which standards are developed. The toxicological and epidemiological literature for a particular substance is thoroughly reviewed and evaluated. For noncarcinogens, the No Observable Adverse Effect Levels (NOAEL's) or Lowest Observable Adverse Effect Levels (LOAEL's), are identified from the available studies according to exposure pathway and duration. The study which provides the highest NOAEL (or lowest LOAEL if a NOAEL is unavailable) that is also scientifically sound is chosen for the risk assessment.

A key factor in determining the NOAEL or LOAEL is exposure duration (USEPA, 1993). Ideally, data will be obtained from studies with an exposure duration comparable to the exposure duration for which the standard is being derived. For example, 1-day, 10-day, Longer-term and Life-time Health Advisories (HA's) are calculated for substances in drinking water by the USEPA for exposed adults and children (ibid). Each HA corresponds approximately to acute, subacute, several years, and lifetime exposures, respectively. Exposure route is also important. For establishing drinking water standards, the oral route is preferred. When available, human data are chosen over results in laboratory animals.

In order to incorporate a margin of safety, uncertainty factors are applied to the NOAEL or LOAEL (USEPA, 1993). These values, also referred to as safety factors, range from 1 to 10,000 depending on the nature and quality of the data. Uncertainty factors are selected based on scientific judgement and attempt to account for inter and intra-species

variability, and any other uncertainty related to the completeness and applicability of the available data. Once the NOAEL or LOAEL is divided by the uncertainty factors, the resulting value, sometimes referred to as a reference dose or acceptable daily intake, is adjusted by the average human body weight (70 kg for adults; 10 kg for children) and water consumption per day (2 liters for adults; 1 liter for children) to arrive at the drinking water standard for a given duration of exposure. These standards are concentration levels at or below which no adverse health effects are anticipated (Lam et al, 1994; USEPA, 1993).

The MDWL Relied Upon by the Draft EIR for Diorganotins is Too High

- Minimum effective and no-observed-adverse-effect doses for dibutyltins were described in the Environmental Health Criteria document on organotins (WHO, 1980). Dibutyltin sulfide administered to rats at oral doses of 1.0, 0.1, 0.01, and 0.001 mg/kg body weight per day for 7 months was tolerated without any detected adverse effects up to a dose of 0.01 mg/kg/day. Higher levels caused intoxication (Mazaev and Korolev, 1969). Using the results of this study and the USEPA risk assessment methodology as described in ANS/NSF 61 Appendix A, we calculate a MDWL of 3.5 ppb versus the NSF standard of 20 ppb for diorganotins. Our number was derived using the No-Observed-Adverse Effect Level (NOAEL) of 0.01 mg/kg/day divided by an uncertainty factor (UF) of 100 (UF of 10 to account for interspecies extrapolation and a UF of 10 to account for intraspecies variability). The resulting value, referred to as a reference dose (RfD), was then multiplied by the assumed human body weight of 70 kg and divided by the average daily intake of drinking water (2 liters per day) to arrive at the MDWL. To protect children, the MDWL would need to be even lower.
- It is important to note that this MDWL refers to an exposure duration of 7 months in rats and not lifetime exposure. In order to account for a human lifetime exposure to diorganotins one would apply another factor of 10 to obtain a lifetime MDWL of 0.35 ppb. This latter value is approximately 57 times lower than the NSF MDWL of 20 ppb.
- The draft EIR states on page 39 that the Lead agency has reviewed the literature regarding organotins leaching from CPVC pipe and found reported values of 10 ppb initially declining to less than 1 ppb after 20 or so extractions. The results of Boettner et al, (1982) indicate that levels of organotins may exceed a MDWL of 0.35 ppb and thereby result in adverse health effects. The draft EIR cannot conclude that there are no significant adverse health effects resulting from long term exposure to organotins in leachate without considering the aformentioned analysis.

The STEL Relied Upon by the Draft EIR for Organotins May Be Too High

- Behavioral studies with monomethyltin have shown that these compounds can induce learning deficiencies in young rats (Noland et al, 1982). Exposure of rat pups to monomethyltin chloride via their dams drinking water throughout gestation and postpartum for 21 days experienced significant learning deficits and changes in locomotor activity levels. Animals in all dose groups (12, 40, 120 mg/l of tin) displayed some learning disability compared with the controls.
- Using the dose of 12 mg/l as the Lowest-Observed-Adverse Effect Level (LOAEL) and the USEPA risk assessment methdology (as described in CH2M Hill, 1987) we calculate a (subacute) short term exposure level of 30 ppb as follows:

  12 mg/l X 25 ml water/day X 1 l/1000 ml = 0.3 mg/rat/day

  -where 12 mg/l is the LOAEL

  -25 ml water/day is the average amount of water consumed by the rat

  -1 l/ 1000 ml converts liters to millilters

  -0.3 mg/rat/day is the estimated dose per rat per day

  Using the dose per rat and weight of the average rat, we convert the dose per rat per day to a dose in milligrams per kilograms of weight per day:

  0.3 mg/rat/day X 1 rat/0.350 kg rat = 0.86 mg/kg/day
- Using an UF of 1000 to account for extrapolation of a LOAEL to a NOAEL, interspecies extrapolation, and intraspecies variability (factor of 10 for each "uncertainty"), the assumed average human weight (70 kg) and the assumed average water consumption per day (2 l/day), we calculate an STEL (subacute) of 30 ppb. This value is approximately three times lower than the NSF standard of 100 ppb.
- Furthermore, Boettner et al (1982) reported initial concentrations of organotins in CPVC pipe leachate that could exceed a STEL of 30 ppb. As a consequence, adverse health effects resulting from subacute exposure to organotins would not be unexpected. The draft EIR cannot conclude that there are no significant adverse health effects resulting from short term exposure to organotins in leachate without considering the aformentioned analysis.

The MAL's Relied Upon by the Draft EIR for MEK and Acetone are Too High

- The USEPA has developed a health advisory for methyl ethyl ketone (MEK) that indicates a long term level for drinking water of 200 ppb (CH_2M Hill, 1987; 1989 draft EIR). This standard is 5 times lower than the MDWL calculated by the NSF.
- The USEPA health advisory for MEK and the NSF MAL's for acetone and MEK are derived and based on exposure to these chemicals individually. As a consequence, these standards will underestimate the potential health risks since their major toxic effects are not due to exposure to these chemicals alone but in combination with other chemicals whose toxicity they potentiate. Hewitt et al (1986) showed that a dose of MEK as small as 0.072 g/kg potentiated the toxic effects of chloroform given 18 hours later. Lower doses were not studied. Using 0.072 g/kg as a LOAEL divided by a UF of 1000 (UF's of 10 to account extrapolation of a LOAEL to a NOAEL, intra and interspecies variability) gives a RfD of 72 ug/kg. Multiplication of the RfD by the assumed human body weight of 70 kg and division by the average daily intake of drinking water (2 liters per day) gives a STEL based on a one time exposure to MEK of 2.5 ppm in the presence of chloroform versus the NSF's STEL of 32 ppm. Note that chloroform is an ubiquitous contaminant of chlorinated drinking water (ATSDR, 1997; CHDS, 1997; Lam et al, 1990) and may also be present in CPVC pipe leachate (Draft EIR, pages 39 and 41). Based on the aforementioned discussion, the draft EIR cannot conclude that the NSF standards would protect against significant adverse health effects resulting from exposure to MEK and acetone without considering potentiated toxic effects.

The NSF has Calculated MAL's for THF Which are Lower Than Those Stated in the Draft EIR

An NSF draft document entitled "Tetrahydrofuran MAL Report" (Whittaker, 1997) describes the calculation of a STEL of 6.26 ppm for THF versus the STEL of 100 ppm cited in the draft EIR. Also, Whittaker (1997) reports a MDWL of 20 ppb for THF versus the level of 1 ppm reported in the document. It is important to note that although these standards are significantly lower than the values reported in the draft EIR, they do not account for multipathway exposures, the potential for synergistic or additive effects, and the exposure of infants and children. In order to properly evaluate the health effects from project THF exposures, the draft EIR must consider the proposed MAL's for THF and must also account for multipathway exposures, synergistic or additive effects, and exposure of infants and children.

Conclusions by the Draft EIR based on the NSF Standards

It is important to note that the draft EIR arrives at its conclusions that CPVC solvent and pipe leachate would not occur at levels that would constitute a significant health impact based on comparison of data from leaching studies with the NSF standards. However, the data from the leaching studies relied upon by the draft EIR are not described in the document or its technical appendix. It is impossible to comment meaningfully on the draft EIR's conclusions without this information. All studies in the peer-reviewed published literature should be included in this comparison. It is important to note that there are few if any published studies that have examined levels of all potential solvent and pipe leachate after long term use of CPVC pipe for potable water.

As demonstrated above, at least six of the NSF standards relied upon by the draft EIR are not health protective. Furthermore, none of the standards account for exposures through multipathways nor synergistic or additive effects. It is also unclear if these levels have accounted for exposure to children as well as adults. Therefore, any conclusions of the draft EIR that the concentrations in leachate are below the threshold of any measureable effects known have not been substantiated. We find that significant adverse health effects would not be unexpected at the current NSF standards.

Finally, the statement on page 21 that "neither USEPA nor the California Department of Health Services have established maximum contaminant levels (MCL's) for solvents used to join CPVC pipe may be due to the relatively low toxicity of these substances" is speculative and should be deleted. In many cases, standards are not developed because the underlying toxicological and/or epidemiological data on which they must be based are not available.

Conclusions of the Draft EIR based on the Risk Assessment Conducted by CH2M Hill

The draft EIR states on page 36 that the Lead Agency previously examined the contamination of drinking water by CPVC related solvents and copper pipe leachate in a comparative health risk assessment conducted under contract by CH2M Hill (1987). This report concluded that the health risks due to CPVC pipe leachate were found to be essentially nonexistent. There are several problems with the risk assessment that makes its conclusions invalid:

- The concentrations of leachate from a 75-day study were compared with Maximum Contaminant Levels or Health Advisories for CPVC solvents. As is the case with the

present draft EIR, the standards on which the conclusions are based did not account for multipathway exposures, synergistic and additive effects, and the exposure of infants and children.

- At the time the risk assessment was conducted, the carcinogenicity of THF was unknown. The leaching study depended upon by the risk assessment measured an average high usage concentration of THF in municipal water of 2700 ppb (CH2M Hill, 1987). The average low usage concentration for THF was 810 ppb. These levels of THF are approximately 40 to 135 times higher than the NSF MDWL for THF of 20 ppb. As discussed in the section on NSF standards, the MDWL of 20 ppb may not be adequately health protective.
- Leachate levels and health effects of organotins were not considered in the risk assessment.

Background Levels of Organotins and Solvents Used for CPVC Pipe

The draft EIR's statements that "only one of four solvents (MEK) used in CPVC has been detected in drinking water" (page 20) and that "DHS is not aware of any detection of the organotin stabilizers in the State's drinking water sources" are misleading. According to the "Drinking Water Quality Monitoring Data 1984-1996 Annual Status Report" (CDHS, 1997), only MEK and acetone have been analyzed. Table A-7 in this same document lists initial sampling for chemicals in public drinking water sources according to each year testing has been conducted. Organotins, THF, and cyclohexanone are not included in the testing (ibid). Thus, there is no factual basis to support the draft EIR's suggestion that organotins are not present in California drinking water sources.

Available Information on the Potential Carcinogenic, Reproductive and Developmental Effects of Solvent Origin Leachates

The draft EIR's statement on page 35 that none of CPVC solvents "are classified as human carcinogens by any agency, nor are they known to be reproductive/developmental toxicants" is misleading and is an inaccurate representation of the health effects information available for these chemicals.

- Acetone has not been tested for carcinogencity in experimental animals nor are there data available in the literature regarding its cancer causing potential in humans (ATSDR, 1994). There is some evidence of fetotoxicity, and effects on reproduction and

development in exposed animals (ibid). Shortening of the menstrual cycle in humans has also been observed (ibid).

- The International Agency for Research on Cancer (IARC, 1989) has stated that the there is inadequate evidence of the carcinogenicity of cyclohexanone based on one bioassay where slightly elevated tumor incidences were observed at low but not high doses in exposed rats and mice. No prenatal toxicity has been observed in mice exposed to cyclohexanone (ibid). There are no studies available regarding reproductive, developmental, or carcinogenic effects of exposure to cyclohexanone in humans.

- There are no long term studies of the carcinogenicity of MEK in experimental animals (WHO, 1993). The results of epidemiological studies of cancer are inconclusive due to bias in the form of the "Healthy Worker Effect", inadequate follow-up, insufficient power, and/or exposure misclassification (ibid). The total number of litters containing fetuses with anomalous skeletons was significantly increased in rats exposed to MEK by inhalation (Schwetz et al, 1974). It was concluded that MEK is embryotoxic, fetotoxic and potentially teratogenic without inducing maternal toxicity. Deacon et al (1981) found MEK to be slightly fetotoxic with some minor variations in the development of the fetal skeleton. There are no data in the literature concerning the reproductive or developmental effects of exposure to MEK in humans. However, Lowengart et al (1987) conducted a case-control study of children less than 10 years of age to investigate the causes of leukemia. Analysis of information from 123 matched pairs showed an increased risk of leukemia for children whose fathers had occupational exposure after the birth of the child to MEK (OR=3.0).

- There are no studies regarding the carcinogenic, reproductive or developmental effects of THF in humans. Mast et al (1991) evaluated the potential for developmental toxicity in rats and mice exposed to THF by inhalation. The investigators concluded that THF may be embryotoxic in mice, but if the conceptus survives, development as assessed by this experimental design continues in a normal fashion. The embryotoxicity of THF administered to rats on days 6 through 15 of gestation was expressed as developmental delay of the fetus (USEPA/OTS 1992). It has been concluded that there is some evidence in male rats and clear evidence in female mice of the carcinogenicity of THF via inhalation exposure (Chhabra et al 1998; NTP, 1996).

In summary, the fact that MEK and acetone have not been classified as carcinogens by any agency may be due to the scarcity of data. Consequently, it is premature to conclude that long term exposure to these chemicals would not cause carcinogenic effects. Moreover, the few studies that have been conducted indicate that reproductive and developmental effects could result from exposure to MEK and acetone. Recent results from the National

Toxicology Program provide evidence for the carcinogenicity of THF. Mischaracterization and disregard of the results of this study by the draft EIR are discussed in detail in the next section.

Potential Carcinogenicity of THF

The conclusions in the document regarding the National Toxicology Program (NTP) bioassay of the carcinogenicity of THF are misleading and inaccurate. The authors of the draft EIR have improperly dismissed the results and conclusions of the NTP by mischaracterizing standard animal cancer bioasssay protocol, and by ignoring the relevance and importance of the use of these studies in determining the potential for carcinogenicity in humans.

The 2-year NTP inhalation study provided evidence of the carcinogenicity of THF in laboratory animals (Chhabra et al, 1998; NTP, 1996). Renal tubule epithelial adenomas and carcinomas were induced in male rats and were considered to be related to the administration of THF. Although not statistically significant, the combined incidence of adenomas and carcinomas exceeded the historical range for controls in 2-year NTP inhalation studies and occurred with a positive trend in the 600 ppm and 1800 ppm dose groups. Similarly, the incidence and multiplicity of liver neoplasms in female mice were significantly greater than controls in the 1800 ppm dose group. Increases in the 200 ppm and 600 ppm exposure groups were not statistically significant but did show a dose-response relationship. The investigators noted that furan and 1,4- dioxane, chemicals structurally related to THF, have also been shown to cause cancer in rats and guinea pigs (IARC, 1976; NTP, 1993a). The liver was one of the major sites where tumors were induced. Because there is little evidence of its mutagenicity in a variety or *in vitro* and *in vivo* assays, the carcinogenic activity of THF is believed to occur through nongenotoxic modes of action (Chhabra et al, 1998; NTP, 1996). The NTP concluded that based on the results of this study, the Threshold Limit Value (TLV) for THF of 200 ppm is too high since tumors were induced in mice at this dose (exposure of workers installing CPVC pipe to THF will be discussed in detail in a later section).

Animal cancer bioassays are conducted at high doses in an attempt to provide sufficient statistical power to detect a cancer risk among the relatively small number of animals tested (USEPA, 1996). The highest dose chosen is generally one that has been shown to be minimally toxic and is known as the Maximum Tolerated Dose (MTD). Note that most chemicals shown to be carcinogenic in humans have been found in occupational

settings where workers were exposed to toxic high doses- a situation similar to the rodent bioassay (Popp, 1984).

A carcinogenic effect at the highest dose may be a consequence of cell killing rather than an inherent carcinogenicity of the substance tested (USEPA, 1996). If sufficient data demonstrate that the effects seen are solely the result of excessive toxicity rather than carcinogenicity of the substance tested, then the effects may be considered as inappropriate to include in an assessment of the potential for human carcinogenicity (ibid). However, this does not appear to be the case in the NTP bioassay of THF. Excessive toxicity was observed in the highest dose group of male mice with a concomitant decrease in survival relative to the controls (Chhabra et al, 1988; NTP, 1996). Neoplastic lesions were not observed in this group of animals relative to the controls. No other manifestations of excessive toxicity were observed in the remaining animals in the study, including those dose groups in which tumors were induced.

The draft EIR statement that THF is not considered to be a human carcinogen is misleading and is contrary to standard public health regulatory practice. As stated in the previous section, there are no studies of the carcinogenicity of THF in humans. If no human data are available, it is assumed that cancer demonstrated in animals indicates that the agent tested can also have carcinogenic potential in humans (USEPA, 1996). The assumption is public health protective and is supported by the fact that nearly all of the agents known to cause cancer in humans do so in animals when adequately tested (IARC, 1994; Tomatis et al, 1989; Huff, 1993). Furthermore, nearly one-third of human carcinogens were identified subsequent to animal testing (Huff, 1993). Conversely, of 82 chemicals for which there is some epidemiological evidence of human carcinogenicity, all but one (arsenic) that have been tested in laboratory animals have been shown to be carcinogenic (Maugh, 1978). Additional support for the relevance of animal data to predict human cancer comes from research on the processes of cancer at the molecular level that show remarkable similarity among species (USEPA, 1996).

There has been much discussion concerning the relevance of the mouse liver tumor to human carcinogenesis (Goodman et al 1991; Popp, 1984). The use of the B6C3F1 mouse has been criticized due to the high rate of spontaneous liver tumor development, particularly in males. Nevertheless, the mouse has been considered a reasonable test animal for hazard identification since its genetic background may act as an amplifier of any tested substances potential carcinogenic activity (Stevenson et al, 1990). If THF were found to cause only liver tumors in mice and no tumors of any type in other species, their significance might be justifiably questioned (USEPA, 1996). However, under the

conditions of the NTP bioassay, THF caused a neoplastic response at multiple sites (liver and kidney) in more than one species (positive response in the rat and mouse) and in more than one sex (female mice and male rats). Thus, taking into account the overall weight of evidence, the induction of liver tumors in mice by THF may be predictive of a carcinogenic response in humans.

The NTP study presents evidence of THF as a potential human carcinogen. The draft EIR's failure to consider this potential carcinogenicity in evaluating public and worker exposures to THF is contrary to public health regulatory practice and standards.

Multipathway Exposures to Solvent Origin Leachates

The draft EIR has completely ignored exposure to CPVC pipe solvent origin leachate through dermal and inhalation pathways in its health risk analysis. Exposure through these pathways have been shown to be significant in a multitude of studies, some of which have been published since completion of the 1989 draft EIR. Those studies cited in the comments submitted by Smith and Wright on the 1989 draft EIR on behalf of the California Pipe Trades Council are not repeated here, but are incorporated by this reference.

- Weisel and Jo (1996) studied dermal and inhalation exposures to volatile organic compounds (VOC's) in human volunteers. The chloroform and trichloroethene concentrations in exhaled breath were elevated in each subject after both inhalation and dermal exposure during showering demonstrating that chemicals in the water entered the body by both routes. Breath concentrations were also elevated after dermal exposure via bathing. In contrast to ingestion, after inhalation and dermal exposure, the exhaled breath had elevated levels for extended time periods, indicating that the compounds were distributed throughout the bloodstream before being metabolized. The expiration data demonstrated that dermal exposure contributes as much to the body burden of chloroform or trichloroethene as inhalation exposure while showering with water containing these contaminants. Extended bathing yielded an even greater dose. It was concluded that for typical activities of drinking and showering, each exposure route contributes similar internal doses and that the total internal dose from a 10 minute shower or a 30 minute bath is greater than that from ingesting 2 liters of water.
- Wilkes et al (1996) evaluated the range of possible inhalation doses taking into account varying activity patterns and water uses. The mean daily potential inhalation dose (PID) predicted in this study ranged from approximately 21 to 39 ug/day. This compared to a PID resulting from drinking between 1 and 2 liters of the same contaminated water. The investigators noted that the 95th percentile value for each group was much higher,

ranging from approximately 70 ug/day to 103 ug/day. The equivalent PID would be reached by drinking 3.5 to 5 liters of water, respectively.

- Experiments were performed in an intact unoccupied house in an attempt to quantify the transfer of pollutants (trichloroethylene) from tap water in showers to indoor air (McKone and Knezovich, 1991). The results of this investigation suggest that inhalation exposure in showers could be equivalent to ingestion of 1 to 4 liters of tap water.
- A three compartment model was used to estimate inhalation exposure to VOC's released from all water uses indoors (McKone 1987). The model was applied to VOC's including chloroform detected in California water supplies. Estimates of the ratio of inhalation uptake to ingestion uptake ranged from 0.8 to 6.
- Measurements of air concentrations of trichloroethylene (TCE) in showers using TCE contaminated drinking water showed increases with time to as high as one third of the occupational TLV (Andelman, 1985).
- Giardino and Andelman (1996) characterized the emissions of three VOC's commonly found in drinking water (TCE, chloroform, and the pesticide DBCP) in a experimental shower and found that the temperature of the water constituted the major effect on the rate and extent of volatilization. Other factors include nature of the volatilizing chemical, air and water flow rates, and nature of the water use (e.g., bath versus shower). The extent of volatilization for such VOC's as chloroform ranged from 50% to 90% (Andelman, 1990).

As illustrated by the results of the aformentioned studies, the exclusion of dermal and inhalation pathways of exposure leads to a significant underestimation of the potential health risks from solvent origin leachates. Consequently, it is not possible to conclude that no significant health impacts would result by simply comparing the levels of solvents determined from the leaching studies with the MDWL's and STEL's based on oral ingestion alone.

Synergistic and Additive Effects of Solvent Leachate

The draft EIR's assertion on page 38 that "In the cases of the solvents used in CPVC primers and cements, there is no evidence to suggest synergistic effects between the four solvents" is misleading. The draft EIR has failed to present and consider in its analysis the evidence demonstrating the ability of MEK, acetone and possibly THF to potentiate the toxic effects of other chemicals including common contaminants of tap water. Potentiation

of toxicity, particularly due to acetone and MEK, would be expected to be significant since even an increase of naturally occurring ketones in the body via diabetes can precipitate potentiation (WHO, 1993).

The principal toxic effects associated with exposure to MEK are its ability to potentiate the known toxicity of other solvents (WHO, 1993). A multitude of studies in experimental animals have demonstrated MEK's capacity to enhance liver and kidney toxicity of the haloalkanes. The most studied interactions have been with carbon tetrachloride and chloroform. In rats, at doses used, MEK and the haloalkanes separately produced mild liver and kidney injury at most. When exposure to MEK was followed within 10 to 48 hours by a haloalkane, there was severe injury to the liver, with marked and abrupt replacement of normal hepatic cells by necrotic and fatty vacuolated tissue (Hewitt et al, 1986). A dose as small as 0.072 g/kg potentiated the affects of chloroform given 18 hours later. Lower doses were not studied.

While acetone itself is only moderately toxic, it potentiates the toxicity of a variety of chemicals (ATSDR, 1994). The best studied interactions are with carbon tetrachloride and chloroform. One of the most studied effects of acetone is its ability to induce microsomal enzymes (ibid). Acetone induces its own metabolism by this mechanism and potentiates the toxicity of numerous other chemicals by enhancing their metabolism to reactive intermediates. This induction has been documented in many species and therefore poses a concern for humans exposed to acetone and the chemicals whose toxicity is potentiated by acetone (ibid). Charbonneau et al, (1991) studied the effect of acetone on the severity of liver injury caused by haloalkane mixtures. The results showed first that the individual haloalkanes were not hepatotoxic when administered alone to rats at the doses tested. Acetone pretreatment, however, potentiated liver injury of chloroform, carbon tetrachloride, 1,1-dichloroethylene, and 1,1,2-trichloroethane at these same doses. Hewitt and Plaa (1983) demonstrated that the potentiation of 1,1,2-trichloroethane and 1,1,-dichloroethylene hepatotoxicity by acetone followed a biphasic dose response curve. Low dosages of acetone increased the liver toxicity of these chemicals whereas higher dosages were without effect or in some cases protected against hepatotoxicity.

Chloroform induced nephrotoxicity is potentiated by pretreatment with MEK and acetone (Hewitt and Brown, 1984; Raymond and Plaa, 1995). Brown and Hewitt (1984) demonstrated that MEK and acetone produced a dose-related potentiation of chloroform liver and kidney injury. The relationship between ketone dosage and magnitude of potentiated response was nonlinear. Maximum potentiation of chloroform toxicity occurred at lower dose ranges. Greater dosages were associated with a reduction in the degree of chloroform injury.

THF has been shown to enhance the toxic action of a number of compounds, in particular by stimulating increased absorption of reactive metabolites (Moody, 1991). While there is little evidence to suggest that it would be a direct hepatotoxin at relatively low doses, THF's ability to inhibit drug metabolism reactions and enhance the absorbance of reactive metabolites may potentiate a hepatotoxic response (ibid). Hepatotoxicity is one of the more consistent responses noted in acute and chronic exposures to THF (ibid).

Based on the results of the aforementioned studies, adverse health effects from co-exposure to MEK, acetone or THF and other common contaminants of drinking water would not be unexpected.

Health Effects of Organotins in Leachate

The conclusion that pipe origin leachate in the form of organotins is not likely to cause adverse health effects or significant environmental contamination is not substantiated by any published data and references from the literature. As discussed previously in the section on NSF standards, the MAL's on which the draft EIR's conclusions are based are not adequately health-protective.

The draft EIR's statement on page 40 that "the organotins used as stabilizers in CPVC are far less toxic than TBTO" is misleading and inaccurate. The draft EIR has ignored the potential health effects of exposure to diorganotins, particularly those studies published since the 1989 draft EIR. A brief summary of this information is presented below. It is also important to note that little data are available regarding the potential health effects of long term exposure to organotins.

The target organs of exposure to organotins are the central nervous system, skin, liver and bile duct, immune and reproductive systems (Snoeij et al, 1987; WHO, 1980). There are few data regarding the toxicity of mono organotins but they are believed to be the least toxic of this class of compounds (Hunt and Wilkinson, 1990; WHO, 1980). As discussed in the draft EIR, triorganotins are highly toxic to the central nervous system. Both di and triorganotins are irritants to the skin and eyes of animals and man, and are powerful metabolic inhibitors (Snoeij et al, 1987; WHO, 1980). With regards to their effects on the liver and bile duct, immunotoxicity, and reproductive and developmental toxicity, diorganotins are the most toxic of organotins tested (Ema et al, 1995; Seinen et al, 1977; Snoeij et al, 1987, 1988; Ueno et al, 1994).

Diorganotins are hepatotoxic (Seinen et al, 1977; Snoeij et al, 1987; WHO, 1980). Acute exposure to dibutyltin can cause inflammatory changes in the bile duct which can

lead to peritonitis and pancreatitis. The latter disease may follow a chronic course (Merkord et al, 1997). DBTC-induced acute pancreatitis in rats is studied as a type of experimental pancreatitis that resembles the human form of this disease (ibid). Necrotic changes have been produced in the livers of mice, rats and rabbits after short term and subchronic exposure to diorganotins (Seinen et al, 1977; Snoeij et al, 1987; WHO, 1980). Ueno et al (1994) compared the hepatotoxicity of mono, di and triorganotins in mice and concluded that dibutyltin dichloride (DBTC) is more hepatotoxic than tributyltin chloride (TBTC).

Diorganotins have a marked selective effect on the immune system, especially t-lymphocytes (Hunt and Wilkinson, 1990; Seinen et al, 1977; Snoeij et al, 1987; WHO, 1980). Dibutyltins cause a dose dependent atrophy of the thymus, spleen and lymph nodes. As a consequence of their selective lymphocytotoxicity, dibutyltins cause immunosuppression especially of cell mediated immunity. T-cell dependent humoral immunity was also decreased upon dialkyltin exposure (Snoeij et al, 1987). Li et al (1982) demonstrated that DBTC impaired antibody formation by lymphocyctes. These effects were observed at doses with low cytotoxicity. Some trialkyltins are also immunotoxic. Tributyltin-induced thymus atrophy is believed to be caused by its metabolite dibutyltin (Snoeij et al, 1988).

Diorganotins are potent teratogens (Ema et al, 1992, 1995; 1996a; Noda et al, 1992, 1993). Administration of dibutytin during early organogenesis resulted in marked embryolethality and teratogenicity. Oral administration of DBTC to pregnant rats through the period of organogenesis resulted in a significant increase in the incidence of fetuses with malformations even at a dose which did not induce maternal toxicity. Embryos were very highly susceptible to teratogenic effects when exposed on days 7 and 8 of gestation.

Ema et al (1995) compared the developmental toxicity of butyltin trichloride, DBTC, and TBTC in rats during the susceptible period for the teratogenesis of DBTC. Treatment with DBTC resulted in a significantly lower maternal weight gain, lower fetal weight and higher postimplantation embryolethality. A significant and markedly increased incidence of fetuses with malformations such as exencephaly, cleft jaw, cleft lip, ankyloglossia (abnormal shortness of the frenum of the tongue), club foot, deformity of the vertebral column in the cervical and thoracic regions and of the ribs, and ano or microphthalmia (abnormal small size of the eyes) were observed. TBTC was found to be embryotoxic but not teratogenic.

Noda et al (1993) studied the teratogenic effects of various dibutyltins and found that the di-*n*-butyl group rather than the anionic group was important in the teratogenicity of dibutyltin compounds as well as in the other kinds of toxicities. Although the incidence of fetuses with malformations was different, the number of dams with external or skeletal

malformed fetuses were similar within these organotin treated groups. Therefore, there may be no significant difference in the teratogenic potency among the various dibutyltin compounds.

Ema et al (1996b) demonstrated that *in vitro* exposure to DBTC interferes with normal development of embryos during 3 different stages of organogenesis in a dose dependent manner, and that susceptibility to embryotoxicity including the dysmorphogenic potential of DBTC varies with developmental stages of the embryos. Embryos during earlier stages appear to be much more sensitive to *in vitro* exposure than during late stages. These results are consistent with Ema et al (1996a) where the developmental toxicity of DBTC was manifested only by a significant decrease in weight of fetuses during late organogenesis. In contrast, administration of DBTC during early organogenesis resulted in marked embryolethality and teratogenicity. Noda et al (1994) found that dibutyltin is transferred to embryos, and embryonic levels of DBTC exceed those in maternal blood suggesting that rat embryos may be able to accumulate DBTC.

Rat embryo limb bud cell culture system has been employed as a teratogenicity screen on the assumption that chemicals which have specific action on cell differentiation are likely to have teratogenic potential (Yonemoto et al, 1993). Except for monobutyltin, the organotins tested were very strong inhibitors of cell differentiation and cell proliferation compared with teratogenic metal compounds. The results of this study suggest that dibutyltins have the highest teratogenic potential (ibid).

As presented in the section on NSF standards, Noland et al (1982) demonstrated that monomethyltin can induce learning deficiencies in young rats. Exposure of rat pups to monomethyltin chloride via their dams drinking water throughout gestation and postpartum for 21 days experienced significant learning deficits and changes in locomotor activity levels. Animals in all dose groups (12, 40, 120 mg/l of tin) displayed some learning disability compared with the controls. Concentrations of organotins in CPVC pipe leachate could exceed a STEL derived from the results of this study (Boettner et al, 1982).

There are no studies of the chronic toxicity or carcinogenicity of organotins in humans and few studies have been conducted in animals (Hunt and Wilkinson, 1990; WHO, 1980; WHO, 1990). The data on the carcinogenicity of organotins is limited to only a few compounds. Some studies have given negative results while others were equivocal (ibid). Ciba-Geigy conducted a 2 year carcinogenicity study of a mixture of octyltins and found a significantly increased frequency of primary tumors of the thymus (Hunt and Wilkinson, 1990). Organotins have been shown to be genotoxic in a variety of *in vitro* and *in vivo* mammalian cell and bacterial assays suggesting that they are potentially carcinogenic

(Hamasaki et al, 1993; Li et al, 1982; Sasaki et al 1993). Dibutyltins were shown to be genotoxic in mammalian cells at concentrations less than 1ppm (Li et al, 1982). Sakaki et al (1993) found that the number of chromosome aberrations in Chinese hamster ovary cells induced by chlorinated tap water extract was increased by post-treatment with organotins.

Based on the results of the aforementioned studies, significant adverse health effects resulting from exposure to diorganotins would not be unexpected. These effects include toxicity to the immune system, liver and bile duct, and the reproductive system. Also, diorganotins are potent teratogens and exposure to mono-organotins *in utero* can result in behavioral effects. Furthermore, the genotoxicity of organotins suggest that they are potentially carcinogenic.

Disinfection By-Products

As stated by the draft EIR, the solvents contained in CPVC pipe cements can leach into drinking water and serve as trihalomethane (THM) precursors. Also, THMs can be formed and/or are used in CPVC manufacture. The document has not provided data to support its claims that the levels of THMs contributed by CPVC pipe, in particular chloroform, would not significantly impact the already exisiting concentrations and health risks of common contaminants of drinking water. Note that the annual status report on drinking water quality in California (CDHS, 1997) and Lam et al (1994) stated that the most frequently observed VOC's continue to be chlorinated hydrocarbons and THMs. Furthermore, over the past years of sampling and testing new sources and chemicals, the number of detections and MCL exceedances has increased proportionally. This trend continued in 1996 indicating that on a statewide basis more detections and MCL exceedances are seen as more new sources are tested (CHDS, 1997).

As discussed in an earlier section of this commentary, acetone and MEK can potentiate the toxic effects of THMs commonly found in tap water and that these effects can occur at low concentrations. Similarly, the potential significance of exposure to THMs through inhalation and dermal pathways has not been considered. Also, although MEK is not chemically reactive under conditions found in most natural waters, water containing free halogens (such as chlorine) or hypohalides can result in the formation of chloroform. The investigators stated that this can be a cause for concern in chlorinated waste water and water supplies since the chloroform thus produced is more toxic than the original MEK (USEPA, 1985).

Chloroform has been shown to be embryotoxic, fetotoxic, and teratogenic in laboratory animals (ATSDR, 1997). Waller et al (1997) found a modest association

between tap water containing THMs and spontaneous abortion with the risk beginning to increase at approximately 75 ug/l (70 ppb) THM. Although the study suffered from nondifferential exposure misclassification which would underestimate the observed risks, there was no recall or selection bias. Also, follow up of the cohort was virtually complete. The investigators stated that it is not unusual for concentrations of THMs to exceed 75 ug/L in chlorinated drinking water. Kramer et al (1982) studied developmental effects in humans after exposure to chloroform. The estimated relative risk for intrauterine growth retardation associated with drinking water supplies with chloroform concentrations of greater than 10 ppb was 80% higher than the risks for sources with undetectable levels of chloroform. Drinking water sources with levels of chloroform ranging from 1 to 9 ppb had an elevated risk of 30%. Note that the USEPA's MCL for THMs of 100 ppb is much greater than the concentrations at which effects were reported in each of these studies and that the draft EIR has relied on this standard in its evaluation of potential health risks of disinfection by-products.

Chloroform has been shown to induce liver and kidney tumors in laboratory animals (ATSDR, 1997). Chlorinated drinking water contamination has been consistently linked to gastrointestinal and urinary tract cancer (ATSDR, 1997; Cantor, 1997; Clark and Goodrich, 1986). The results of the epidmiological studies tend to report small relative risks in a range where uncontrolled confounding or other sources of bias might be important. However, some of these studies also suffer from inadequate latency and misclassification of exposure which would tend to underestimate any observed effects (Cantor, 1997). It is important to note that the public health impact of small elevations of risk among large exposed populations, as is the case with exposure to chlorinated drinking water, can be substantial (ibid).

The National Toxicology Program conducted a series of studies in rats and mice exposed via the drinking water to a chemical mixture of 25 groundwater contaminants at concentrations with environmental relevance (NTP, 1993b). Although there was no clear evidence of toxicity in the 26 week study in mice, specific studies of immunotoxicity, myelotoxicity and genetic damage showed adverse effects at concentrations similar to those used in the 26 week studies. The fact that studies with typical toxicological endpoints revealed no significant evidence of toxicity in mice suggests that conventional approaches are inadequate to fully assess more subtle toxicity resulting from long term exposure to low levels of environmental contaminants (ibid).

Although it is shrouded in controversy, the USEPA has proposed to raise the MCL for chloroform to 300 ppb (Risk Policy Report, June 1998). As discussed previously in

this section, health effects have been reported from exposure to chloroform at levels lower than the current MCL for THM's of 100 ppb. It is also important to note that raising the level of chloroform in drinking water would result in an increase in the likelihood of toxic interactions between CPVC pipe leachate and chloroform in the drinking water.

The draft EIR does not provide any factual information to substantiate its conclusions that changes in disinfection methods in public water supply systems that will eliminate or at least greatly reduce THM formation will be instituted. Even if this is indeed the case, the draft EIR would need to include an analysis of the data to support the contention that the "other disinfection methods" combined with the use of CPVC pipe for potable water would not result in potential adverse effects.

Depending on the levels of chloroform that would be added to background levels (which are not disclosed by the draft EIR), the chloroform leaching that would be allowed by project approval could result in adverse health effects, including carcinogenic effects. In addition, potentiation of the toxicity of chloroform and other THM's by CPVC leachate would not be unexpected. These issues must be addressed by the draft EIR. The draft EIR's conclusions that there will not be any signifnicant adverse health effects from disinfection by-products is not supported by any analysis or evidence presented in the document.

Threshold Limit Values (TLV's) and Worker Health and Safety

The statements in the draft EIR that TLV's are set to protect the health of workers over their lifetimes with a substantial margin of safety and that TLV's are based on NOAELs are inaccurate. The ACGIH states that TLV's "refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect" (ACGIH, 1988). However, current medical reports regularly show that work-related illness and death occur in workers exposed to toxic substances at levels lower than the TLV's and that these values are often chosen to justify long existing levels of exposure to toxic substances in industrial settings with little relationship to the protection of worker health and safety (Roach and Rappaport, 1990; Tarlau, 1990; Ziem and Castleman, 1989).

In their examination of the development of TLV's, Ziem and Castleman (1989) found that no complete literature searches were done, much medical information was missed, and that the effects of long-term exposure were especially overlooked. For at least 90% of the TLV chemicals, adequate data on chronic effects were unavailable either from

studies in animals or of workers with long term exposure to known concentrations of the chemicals of concern.

The New Jersey Department of Health evaluted the chronic health effects data from the EPA's Integrated Risk Information System (IRIS). Workday air concentrations were calculated for noncarcinogens and carcinogens. The resulting exposure limits were frequently three or more orders of magnitude lower than the TLV's (ibid).

Roach and Rappaport (1990) evaluated the published references of human data used to develop TLV's reported in the 1976 and 1986 editions of "Documentation of Threshold Limit Values" by the ACGIH. The results indicated that where the exposure was at or below the TLV, only a minority of studies showed no adverse effects and the remainder indicated that up to 100% of those exposed had been affected. The analysis also revealed that the authors' conclusions in the references regarding exposure-response relationships at or below the TLV's were generally found to be at odds with the conclusions of the TLV Committee.

The following excerpt is from Roach and Rappaport (1990) regarding the references used by the ACGIH to supposedly validate the TLV's for acetone and MEK (also known as 2-butanone):

> Acetone
>
> Effect. "In view of the widespread use of acetone, its volatility and the paucity of reports of illness, it must be considered one of the least toxic of the common solvents. A limit of 1,000 ppm is recommended." (ACGIH, 1976)
>
> Validation? "Acetone produced slight irritation at 300 ppm, but 500 ppm was still tolerated by most of 10 subjects." (Nelson et al, 1943)
>
> 2-Butanone
>
> Effect. "A TLV of 200 ppm should prevent any injurious effects and minimize complaints about odor and irritation." (ACGIH, 1976)
>
> Validation? "Butanone produced slight nose and throat irritation in some of 10 volunteers at 100 ppm." (Nelson et al, 1943)

Since both MEK and acetone produce irritation of the eyes, nose, and throat in human volunteers at at least half the TLV (ATSDR, 1994; WHO, 1993), it is not surprising that a substantial percentage of plumbers reported experiencing irritation during the installation of CPVC pipe (Bellows, 1989). Note, also that not only are these TLV's

inaccurate, they do not incorporate margins of safety nor are they based on long term exposure.

Similarly, the draft EIR's reliance on the TLV for THF and its conclusions that there is still no information proving adverse health effects of exposure to THF are not substantiated. The potential carcinogenicity of THF has been discussed in detail in an earlier section of this report. Recall, that the NTP concluded that based on the results of the animal cancer bioassay, the TLV for THF of 200 ppm is too high since tumors were induced in mice at this dose. Similarly, alteration of tracheal ciliary activity was observed in rabbits exposed by inhalation to 100 ppm THF (Ikeoka et al, 1984). Furthermore, the TLV committee itself has questioned the validity of the TLV for THF: "given the epithelial changes in the respiratory epithelium of rats that inhaled 200 ppm 4 hours/day, 5 days/week (Elovaara et al, 1984) and in view of the well-known differences in rodent and human anatomical parameters which contribute to upper airway absorbed dose and the associated response, the margin of safety afforded by the TLV for this substance is currently under review by the TLV Committee." (ACGIH, 1986). Indeed, even one of the manufacturers of THF has recommended a 25 ppm level (see Dupont MSDS).

Bellows (1989) found that the probablity that the TLV's for combined short term exposure to THF, MEK, cyclohexanone, and acetone would be exceeded during at least one 15-minute period over a typical workday was 68%. The estimated exceedance probability was 10% for the full shift exposure limits. Since the TLV's are not health protective, these probabilities are obviously much higher. In air samples representating full shift exposures, the average concentrations of THF and MEK were 47 ppm and 10 ppm, respectively. The highest measured full shift exposures were 158 ppm THF and 45 ppm MEK (ibid). Analysis of exposure to THF via urine samples showed that a significant portion of a worker's total THF dose may be absorbed through the skin. The total THF exposure (airborne and dermal) of these workers were estimated to be equivalent to airborne exposures of 150 to 740 ppm.

Based on these exposure data for a CPVC pipe installation worker and the health effects literature for CPVC cement solvents and primers (in particular THF and MEK) significant adverse health effects would be expected from both short term and long term exposure. Such adverse health effects are even more likely to occur under worst case conditions since the results of Bellows (1989) are not based on a worst-case analysis of exposure. Without taking these considerations into account, there is no scientific basis for the draft EIR's findings of no significant adverse health effects on workers as a result of CPVC solvent exposures.

Noncancer Health Effects of THF

As mentioned in the previous section, the statement in the draft EIR that there are no data proving adverse health effects of exposure to THF is inaccurate. In addition to the results of studies already presented in this document, the draft EIR has also disregarded the following published reports of the toxicity in humans exposed to THF:

- THF has been shown to be irritating to the skin, eyes, and mucous membranes. However, no specific concentrations at which these effects occur has been reported (ACGIH, 1991). Headache, dizziness, fatigue, nausea, and tinnitus have also been reported (Elovaara et al, 1984; Juntunen et al, 1984; Stoughton and Robbins, 1936; Tolot et al, 1968)
- There are two case reports of toxic hepatitis in plumbers exposed to THF (Garnier et al, 1989). Both plumbers had been working in confined spaces repairing plastic pipe with THF-containing glue. One plumber had been working in this situation for eight hours a day for three days, while the other had been working for only a few hours before being admitted to the clinic with symptoms. Note that the liver has been shown to be a target organ after subchronic and chronic exposure to THF in laboratory animals (Chhabbra et al, 1990; 1998).
- Tolot et al (1968) reported that liver enzymes were slightly elevated in a worker 6 weeks after an episode of subacute THF poisoning. Liver enzyme activities were elevated in a man exposed to THF together with other potentially hepatotoxic solvents (chloroform and trichloroethylene) (Edling, 1982). Liver biopsy revealed moderate fatty infiltration. Juntunen et al (1984) also observed a transient rise of liver enzymes in a previously healthy individual exposed occupationally to THF.
- Albrecht et al (1987) reported a case of immunoglobulin-A nephropathy in a plumber fitting PVC pipe in a confined space with short term exposure to THF ranging from 389 to 757 ppm. Small amounts of MEK and cyclohexanone were also present. The investigators suggested that the massive short term exposure may have exacerbated predisposition to renal disease. Note that the kidney has been shown to be a target organ after chronic exposure to THF in rodents (Chhabbra et al, 1998).

Based on the results of the aforementioned studies and the exposure data for a CPVC pipe installation worker as described by Bellows (1989), significant adverse health effects would be expected from both short and long term exposure to THF. Without taking these data into account, there is no scientific basis for the draft EIR's findings of no significant adverse health effects on workers as a result of exposure to THF.

Interaction of Acetone, MEK, THF and Solvent Mixtures

The draft EIR disregards the potential of MEK, acetone and THF to interact with other solvent chemicals. As discussed previously in this document, the principal toxic effects noted with MEK and acetone exposure stem from their ability to potentiate the known toxicity of other solvents and that the exposure limits for these chemicals are flawed since they do not account for these effects.

The World Health Organization has concluded that although there are no reports of MEK potentiation of haloalkanes renal and hepatic toxicity in humans, chronic co-exposure to MEK and either unbranched aliphatic or haloalkane solvents represents a significant potential occupational hazard where serious toxic effects could occur (WHO, 1993). MEK potentiation of hexacarbon neurotoxicity may have caused at least one major industrial accident in which an outbreak of polyneuropathy was followed by introduction of MEK into a solvent mixture (Allen et al, 1974).

Dyro (1978) described three case reports of polyneuropathy in shoe factory workers. The workers had been exposed to MEK and acetone or MEK and toluene at concentrations well below the TLV's for these substances. In one plant, the exposure levels for most cementers were in the range of 10 ppm MEK and 25 ppm toluene. Measurements in the second plant showed concentrations of MEK ranging from 21 to 180 ppm and acetone from 36 to 250 ppm. The current TLV's for MEK and acetone are 200 ppm and 750 ppm, respectively.

Adverse effects of solvent mixtures have been described even in the absence of any known potentiated effects. A PVC pipe fitter who worked in confined spaces using MEK and a glue containing 60% THF exhibited effects on the peripheral nervous system that resolved 2 months after exposure ceased (Viader et al, 1975). An otherwise healthy adult with no history of neurological disease experienced generalized convulsions upon awakening from anesthesia. His occupational history revealed over 10 years of experience with PVC pipe insulation. The investigators concluded that the interactions of THF and enfluran may provoke epileptic seizures. Watery eyes, gastric distress, fainting, convulsions, twitching, headache, and spinal pressure were observed in two cases of acute exposure while waterproofing seams of raincoats with resins containing acetone and MEK (Smith and Mayer, 1944). Juntunen et al (1984) described a case report of cerebral convulsions after enfluran anesthesia and occupational exposure to THF.

The results of studies in Finnish car painters suggested that long term exposure to complex solvent mixtures whose components individually and jointly are far below their concentration limits may produce significant adverse effects (Husman, 1980; Husman and Karli, 1980). Likewise, Noma et al (1988) proposed that complex mixtures of VOC's rather than a high concentration of any single compound may be responsible for unhealthy air in buildings. It should be noted that MEK is widely used as a component of solvent mixtures (WHO, 1993).

Based on the aforementioned studies, adverse health effects resulting from the interaction of CPVC solvents would not be unexpected among exposed workers. Without consideration of the available scientific data as described above, it is not possible for the draft EIR to conclude that no adverse health effects would occur.

Low Volatile Organic Compound (VOC) Solvent Cements and Primers

All assertions regarding the safety of the use of low VOC cement solvents and primers by the draft EIR are not substantiated:

- No data are presented regarding the chemical composition of these new formulations. As a consequence, meaningful comments on the potential health risks associated with their use is impossible.
- No data are provided to verify the claims that low VOC formulations would result in emissions of solvents at levels not likely to produce significant health effects in exposed workers nor that their use will result in less leaching.
- As stated in the draft EIR, low VOC formulations in the form of one step cements have not been approved for use.
- The authors of the draft EIR do not take into account that dermal exposure of workers is still likely to occur in most work settings and that the extent of exposure via the dermal route is significant (Bellows, 1989).
- We are informed that the total chemical content of the low VOC solvent cements and primers has not been reduced (Bellows, 1998). If so, no reduction in health risks would be expected.

The failure of the draft EIR to present data on the chemical composition of low VOC solvent cements and primers precludes meaningful comment on their potential health effects. Without such information, there is no support for the draft EIR's conclusions that no significant health effects would result with their use.

Potential for Long Term Health Effects from Acute Exposure

The draft EIR ignores the potential of long term health effects resulting from acute exposure to CPVC solvent cements and primers. One such long term effect on the respiratory system is referred to as Reactive Airways Dysfunction Syndrome (RADS). RADS is distinguished physiologically by chronic persistent nonspecific airway hyper-responsiveness and usually occurs after single brief high-level exposure to an irritant gas, vapor or fume (Brooks et al, 1985). Without consideration of the potential for chronic effects resulting from high short term exposure to CPVC solvents, there is no support to the draft EIR's conclusions of no significant adverse health effects.

Mitigation Measures

The draft EIR's conclusion that simply following the material labels and the recommendations of the Material Safety Data Sheets (MSDS's) would greatly reduce the potential for exposure to solvents is not supported by any facts or analysis. Based on our analysis of labeling requirements and MSDS recommendations, we find that such measures would not reduce exposures. First, they are too general and generic to serve as reliable or effective safe work standards. Second, these and other "mitigation measures" discussed in the draft EIR do not appear practical and enforceable in actual work settings.

Bellows (1989) found that ninety percent of employees in every type of pipe installation had received no health and safety training. Of 78 plastic pipe workers monitored, only two workers said they had been informed about potential hazards of the substances in CPVC pipe primers and cements. Most workers reported that they had read the warning labels on these products and many found such warnings as "avoid contact with skin" and "use only in well-ventilated areas" to be comically impractical (ibid).

For all the above reasons, we conclude that significant health effects in exposed workers would result from repeated exposure to CPVC cement solvents and primers containing acetone, MEK and/or THF.

Health Effects of Leachate from Copper Pipe

The draft EIR does not provide data to substantiate its conclusions that the potential risks from exposure to copper pipe leachate are greater than the potential risks associated with CPVC pipe leachate. This section of the document does not contain a scientific analysis of either leaching data or health effects information regarding copper pipe from the

published literature. What little toxicological data that is presented is frequently discussed without reference to the specific chemicals involved and without citations from the peer-reviewed literature. This is particularly apparent for nonmetallic leachate from fluxes and cutting fluids.

The draft EIR does not provide recent data to support its contentions that current levels of lead leachate from copper pipe are likely to cause adverse health effects. As stated in the document on page 77, after July 1986, the state of California prohibited the use of solders containing more than 0.02 % lead. The information regarding lead exposure that is presented by the draft EIR is cited from studies conducted prior to this date.

The draft EIR has mischaracterized the health effects from exposure to copper. Furthermore, no data are provided to support the assertion that current levels of copper in leachate would result in significant adverse health effects. Unlike the chemicals found in CPVC pipe leachate, copper is necessary for good health (ATSDR, 1990a). Copper has also found its place in pharmacology where it has been used as an anti-inflammatory agent (Garret and Whitehouse, 1987). Deficiency of copper causes abnormal hemoglobin synthesis leading to hypochromic and microcytic anemia (ATSDR, 1990a).

The sudden ingestion of large amounts of copper may lead to acute poisoning (ATSDR, 1990a; Seymour, 1987). However, acute copper poisoning is rare and self-limiting since it induces nausea, vomiting and diarrhea which protect against the more serious systemic effects. Furthermore, one can usually taste copper in drinking water before experiencing adverse effects (ATSDR, 1990a).

The only significant example of copper toxicity in humans is Wilson's disease (ATSDR, 1990a). It is an autosomal recessive disorder that affects normal copper homeostatis and is characterized by hepatic and renal lesions, and hemolytic anemia. There are no studies regarding reproductive effects in humans or animals following oral exposure to copper. However, intrauterine devices (IUD's) containing copper have been used as contraceptive devices in women (ATSDR, 1990a).There are no data to suggest that copper is carcinogenic in animals or man (ibid).

Infants exposed to high levels of copper in the drinking water may have harmful health effects at lower levels than adults because the homeostatic mechanisms for clearing copper from the body and preventing its entry via the intestine have not yet been developed (ATSDR, 1990a). Two infant siblings who consumed copper for about 9 months in their drinking water exhibited harmful liver effects (Mueller-Hoecker et al, 1988). The current USEPA MCL for copper of 1.3 ppm is not adequately health protective for infants and children under 10 years of age (Sidhu et al, 1995). A MCL of 0.3 ppm (300 ppb) has been

proposed that would adequately protect the health of infants, children and adults (ibid). This level would also provide approximately 26% of the nutritional requirement of copper in the diet (ibid). Note that the median and mean levels of copper found in California drinking water are 90 ppb and 167 ppb, respectively (CDHS, 1997).

Based on the aforemention discussion, we conclude that the draft EIR has not scientifically supported its claims that the potential health risks from exposure to current levels of copper and lead from copper pipe leachate are greater than the potential risks associated with CPVC pipe leachate.

Copper in the Environment

The draft EIR has mischaracterized the data regarding the environmental impacts of copper. Copper in natural waters is predominantly found in the Cu (II) state (ATSDR, 1990a). The chemical conditions in most natural waters are such that even at relatively high concentrations, the combined processes of complexation, adsorption, and precipitation control the level of free copper in water and can reduce it to extremely low values (ibid). Furthermore, secondary stage treatment of municipal sewage has been shown to remove on average 49% to 82% soluble copper and 83% to 90% total copper (Aulenbach et al, 1987; Stephenson and Lester, 1987). Also, the production of copper and brass releases relatively little copper to water (ATSDR, 1990a). Copper sulfate is added to lakes, reservoirs, and ponds for controlling algae. However, the levels of copper usually return to pretreatment concentrations within a few days (Perwack et al, 1980).

It is important to note that the draft EIR includes absolutely no discussion or presentation of any data from the scientific literature regarding environmental contamination from the use of CPVC pipe and its potential effects on ecosystems. Consequently, it is not possible for the draft EIR to conclude that the environmental impacts based on the use of copper pipe would be greater than the risks associated with the use of CPVC pipe.

Antagonistic or Competitive Effects of Metal Pipe Leachates

The draft EIR mentions the possibility of synergistic and additive effects of exposure to copper pipe leachate without substantiation with data from the published literature. On the otherhand, the draft EIR, has ignored the results of studies that have found antagonistic effects resulting from co-exposure to metal pipe leachate (i.e., cadmium, copper, zinc). For example, increasing the intake of zinc in the diet has been demonstrated to protect against the onset of copper toxicity in animals (Allen, 1987). Both zinc and

cadmium have been shown interfere with copper absorption and metabolism by competing for common binding sites on metallothionein (ATSDR, 1990a).

Other Metals Leaching from Metal Pipe

No data have been provided to support the implication that levels of cadmium or zinc in leachate from metal pipe used to convey potable water would result in adverse health effects. The draft EIR states on page 78 that zinc is found in relatively high concentrations in water conveyed by galvanized steel pipe yet does not mention that zinc, like copper is an essential element in living organisms and is present in all foods (ATSDR, 1993). Zinc compounds are also found in many pharmaceutical products such as sun blocks, diaper rash ointments, deodorants, athletes foot preparations, acne and poison ivy medications, and antidandruff shampoos (ibid).

Deficiencies of zinc can lead to loss of appetite, a decreased sense of taste and smell, depressed immune function, slow wound healing, and male reproductive damage (ATSDR, 1993). Too little zinc in pregnancy may result in growth retardation and depressed mental function.

Large doses of zinc could cause adverse health effects. Acute exposure can cause gastrointestinal problems including stomach cramps, nausea and vomiting (ATSDR, 1993). Chronic effects resulting from long term exposure to zinc include anemia, damage to the pancreas, and decreased levels of high density lipoprotein (HDL) cholesterol.

The draft EIR states on page 79 that zinc levels in copper and steel pipe leachate range from 29-214 ppb and 232-1279 ppb, respectively. The National Academy of Sciences' (NAS) Recommended Daily Allowances (RDA's) of zinc for infants and children are 5 mg/day and 10 mg/day, respectively (ATSDR, 1993). Assuming a 1 liter consumption of tap water per day would result in intakes for zinc of 5 ppm for infants and 10 ppm for children. Note that the leachate levels from both forms of pipe are much lower than the RDA's for both infants and children.

Long-term oral exposure to cadmium may result in toxicity to the kidneys, bone and gastrointestinal tract (ATSDR, 1998a). Based on limited data, exposure to cadmium via ingestion does not appear to be carcinogenic in animals or man (ibid). The USEPA has set a MCL of 5 ppb for cadmium in drinking water (ibid). The draft EIR states on page 79 that cadmium leachate from steel and copper pipe ranges from 0.26-1.13 ppb and 0.02-0.21 ppb, respectively. Note that the cadmium concentrations in copper pipe leachate are 25 to 250 times lower than the USEPA's MCL for cadmium.

In summary, the draft EIR does not provide data to substantiate the suggestion that levels of zinc and cadmium leaching from steel pipe used to convey potable water would result in any significant adverse health effects.

Nonmetallic Leachates from Metal Pipe

The draft EIR does not provide data to support the assertions that levels of non-metallic leachates from metal pipe might pose a potential health risk. Furthermore, it has not been possible to adequately comment on what little toxicity data is presented in this section since the components of the fluxes and cutting fluids which comprise non-metallic leachate have not been provided in the draft EIR or its technical appendix.

The conclusions of the draft EIR regarding the potential health effects of exposure to soldering fluxes appear to be based on the results of Nikora et al (1998). In this study, laboratory simulated soldering experiments of metal plumbing were conducted. The investigators stated that their results demonstrated the release of potentially toxic organic vapors. However, it is important to note that the study concluded that "many of the identified materials appear to be released at what would be considered a measurable level". Other chemicals were said to be released at trace amounts. Based on the results of this study, it is impossible to conclude that advserse health effects would result from such low exposure to the components of soldering fluxes. Furthermore, no data are provided that would indicate their presence in leachate.

We conclude that the draft EIR has not presented data to substantiate any potential exposure to or any potential health risks resulting from non-metallic pipe leachate.

Worker Health and Safety in the Existing Environment

The draft EIR does not provide data to substantiate its conclusions that the potential risks from working with existing piping materials are greater than the potential risks associated with CPVC pipe installation. As was the case in the section on copper pipe leachate, this portion of the document does not contain a factual presentation or analysis of either worker exposure data or health effects information from the published literature. What little health effects data that is presented is frequently discussed without reference to the specific chemicals involved and without references from the peer-reviewed literature.

The statement on page 94 that "toxic and carcinogenic smokes and vapors are produced during soldering operations and released into the workplace atmosphere" is misleading. Again, the draft EIR has relied on the results of Nikora et al (1998) as a basis

for its conclusions. As stated in the previous section, this study concluded that only "measurable" or "trace" amounts of substances were identified. Copper pipe solders are composed mainly of tin with small amounts (less than 10% in all) of copper, silver or antimony (Bellows, 1989). The results of Nikora et al (1998) did not reveal the presence of tin, antimony, or lead in the respirable smoke particles. Metal fume monitoring of plumbers during copper pipe installation showed that the average 8-hour time-weighted average (TWA) exposures for copper, tin, silver, antimony and lead ranged from 0.2% to 4% of the exposure limits for these metals (Bellows, 1989).

Furthermore, the statement on page 44 that soldering fumes are carcinogenic is incorrect. There are no studies conducted in animals or humans in the published literature that have provided evidence of the carcinogenicity of exposure to soldering fumes. Of the components of copper pipe solders, there is no evidence of the carcinogenicity of copper, tin, or silver in animals and man, and equivocal evidence of the carcinogenicity of antimony and lead (ATSDR, 1990abc; ATSDR, 1992; ATSDR, 1996; ATSDR, 1998b; USEPA, 1993).

The statement by the draft EIR on page 94 that "tin has produced tumors in experimental animals but is not considered to be carcinogenic" is misleading. The NTP conducted a carcinogenesis bioassay for stannous chloride in rats and mice exposed in the diet. Although some tumors were induced in rats and mice, the NTP concluded that the incidences of tumors relative to the historical control rat and mouse data were similar and not clearly related to stannous chloride administration (ATSDR, 1992).

We conclude that the draft EIR does not provide any scientific evidence to support its conclusions that health effects resulting from working with existing piping materials are greater than the potential risks associated with CPVC pipe installation.

Discussion of Chemical Hazard Evaluation in Appendix B

The risk assessment process as described in this section is a biased and unbalanced commentary that should be indicated as the opinions of the preparers of the draft EIR. The risk assessment process is deliberately designed to be health conservative. It is conservative because it is intended to protect the public health including sensitive members of the population. Sensitive individuals generally include children, pregnant women, the elderly, persons with existing diseases, and individuals with lower levels of protective biological mechanisms due to genetic variabililty within the population. Assumptions made are meant to err on the side of public health protection but in many cases are reflective of an average individual (CAPCOA, 1993).

While uncertainties are inherent in the risk assessment process, these are not as one-sided as implied by the draft EIR. Sources of uncertainty that could lead to an underestimation of risk include exposure through more than one pathway, and the possibility of additive, synergistic and/or potentiated health effects which are generally not accounted for using standard risk assessment methodology.

The statement on page 50 that "exposure assumptions for workers are different from those that are applied to the general public, and allowable exposure limits are generally greater" is misleading. The exposure limits are generally greater because they usually refer to short term high level exposures while exposure limits applied to the general public are intended to protect against chronic effects resulting from long term low level exposure to toxic substances. Other mischaracterizations of workplace standards by the draft EIR have been discussed in an earlier section.

CONCLUSION

In summary, we find that the conclusions of the draft EIR that no significant health effects would be associated with the use of CPVC pipe for the distribution of potable water are almost entirely unsupported by the scientific literature. In addition, the draft EIR has failed to disclose the toxicological data and studies which support the NSF standards on which it relies to evaluate the significance of the leaching impacts. The absence of this information precludes any meaningful comment on the established NSF standards. Furthermore, as discussed, the published literature indicates that the Maximum Allowable Limits relied upon by the draft EIR are too high to be adequately health protective.

The draft EIR has failed to adequately present and evaluate available health effects data as discussed in this commentary, and have thereby seriously underestimated the potential health impacts of the extended use of CPVC pipe to both exposed workers and residents. Based on our analysis, we find that significant adverse health effects on workers and drinking water consumers from the proposed CPVC approval would not be unexpected.

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MARK A. CAPITOLO

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April 20, 2005

Tom Enslow
Adams Broadwell Joseph & Cardozo
Sent Via Fax and Email

Dear Tom:

Attached is a report detailing my findings on the survey I have performed on behalf of Adams Broadwell Joseph & Cardozo along with my bio for information purposes.

As you know, I was contracted to perform a phone survey of building departments around the state to assess current enforcement patterns of home and worker safety provisions required during the installation of Chlorinated Polyvinyl Chloride (CPVC) pipe for residential potable water systems.

I am confident that the findings are fair, true and accurate to the best of my abilities.

I want to thank you for the opportunity to work with you and look forward to working together soon.

Sincerely,

Mark A. Capitolo

Executive Summary

Survey calls were made to the building departments of 59 targeted cities and counties between March 21 and April 13, 2005. The cities and counties called were targeted based on their likelihood of allowing use of CPVC pipe for interior residential use due to past reports of problems with corrosion of metal pipe.

First, a plumbing official or specialist was requested. If the locality did not have a specific plumbing official, a plumbing inspector, senior inspector, senior plan checker or the building official typically answered the calls.

After an introduction and explanation of the survey it was determined whether or not the official was willing or had enough information to answer the survey. In total, an official with 46 of the 59 jurisdictions targeted were introduced to the survey. The survey questionnaire is attached as an appendix.

The most significant finding of the survey reveals that the California Plumbing Code's (CPC) home and worker safety provisions that require inspection during installation are completely un-enforced in localities where CPVC is currently being used in residential housing units.

In fact, the survey shows that in many cases building departments are implementing haphazard compliance measures neither called for nor detailed in any way in the CPC.

While no building department reported enforcing the law during installation, some claimed to make attempts to enforce by implementing such procedures as requiring blanket certifications or simply providing the guidelines and advising the applicant in writing of the regulations. Most however, say they depend on self-enforcement or enforce only the provisions that do not require monitoring the installation process.

The widespread lack of enforcement can be summed up in the words of one official who stated, "I don't get too bureaucratic with people."

Where CPVC is Used

Of all 59 localities contacted, 33 officials reported allowing CPVC, 11 reported banning the product, two refused to answer questions and 13 could not or would not return calls requesting information.

Jurisdictions that allow CPVC

Alhambra
Bakersfield
Barstow
Benicia
Beverly Hills
Brea
Brentwood
Burbank
Clairmont
Coachella
Contra Costa County
Corona
Culver City
Danville
Davis
Discovery Bay
Los Angeles County
Lake Elsinore
Livermore
Oakley
Oceanside
Orange County
Perris
Placer County

Calaveras County
Cathedral City
Duarte
Kern County
Riverside County
San Joaquin County
Santa Barbara County
Santa Maria
Tuolumne County

Jurisdictions that have banned CPVC

Adelanto
Clovis
Colton
Escondido
Hemet
Merced County
Moreno Valley
San Bernardino County
Santa Clarita
San Ramon
Vallejo

Jurisdictions that refused

Tulare County
Yucaipa

Jurisdictions that did not respond

Dana Point
Fillmore
Fresno
Garden Grove
Highland
Hollister
City of Los Angeles
Madera County
Nevada County
Porterville
City of San Diego
Stanislaus County
Yuba County

In only six cases did the officials contacted enforce any of the required home and worker safety provisions:

Barstow
Coachella
Davis
Oakley
Los Angeles County
San Joaquin County

Survey Results

A breakdown of some of the key data regarding enforcement is shown below.

Generally, it is reported that no jurisdiction performs inspections during installation and all of the 33 jurisdictions that allow CPVC fail to 100% comply with all of the CPC's mitigation regulations.

Jurisdictions That Allow CPVC	33
Fail to Comply 100%	33/33
Enforce None of the Provisions	27/33
Enforce Some but Not All	6/33
Certification or Advise	6/33
Enforced All of the Flushing Requirements	1/33
Enforced Some of the Flushing Requirements	4/33
Enforced the Ventilation and Glove Requirements	0/33

Of the six jurisdictions that partially enforced the CPVC mitigation measures, most of them only enforced the requirement that the contractor provide a signed, written, worker-safety certification stating that:

> (1) They are aware of the health and safety hazards associated with CPVC plumbing installations.
>
> (2) They have included in their Illness and Injury Prevention Plan the hazards associated with CPVC plumbing pipe installations; and
>
> (3) The worker safety training elements of their Injury and Illness Prevention Plan meets the Department of Industrial Relation's guidelines.

Only *one* jurisdiction fully implemented all of the flushing requirements. One other jurisdiction enforced the initial flush and the warning tag requirement, but did not return to ensure the second flush took place. Two jurisdictions required the architect, engineer or contractor to certify they have complied with the flushing requirement, but did not inspect to ensure compliance. Generally, the sentiment was that "enforcing the second flushing was difficult."

Not one jurisdiction fully enforced the ventilation and glove use measures. When directly asked, none of the building officials felt that enforcing the ventilation and glove use measures was either feasible or effective. Most of them pointed to a lack of manpower and resources. They also stated that enforcement was difficult because "it would require us to be present when they are doing the installation."

One building official stated that his department would need an extra fee to pay for the additional enforcement requirements. The building officials surveyed also complained "it's difficult for building officials to enforce" these provisions because they go "beyond the scope of their jobs."

STEPHEN K. HOPCRAFT

COMMUNICATIONS CONSULTING

AB 151 HEALTH AND SAFETY MEASURE ENFORCEMENT SURVEY REPORT

Prepared by:

Hopcraft Communications
3551 'N' Street
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(916) 457-5546

For:

Coalition for Safe Building Materials

April 9, 1998

❒ SUMMARY OF FINDINGS

- No building official enforced the requirement that workers wear protective impermeable gloves

- No building official enforced the requirement that employers provide eyewash stations

- No building official enforced the requirement that employers regularly inspect and maintain acetylene tanks

- Only one building official enforced the requirement that enclosed spaces be ventilated with portable fans

- Only one building official enforced the requirement that CPVC cement applicators and daubers be limited to small sizes

- Only two building officials enforced the requirement that the completed plumbing system be flushed

- No building official maintained any inspection reports or other records of compliance with AB 151 health and safety measures

❒ INTRODUCTION

California has long banned the use of chlorinated polyvinyl chloride ("CPVC") pipe to carry drinking water due to concerns about the leaching of toxic and carcinogenic chemicals into the drinking water carried by the pipe, and because of the exposure of workers installing the pipe to toxic chemicals contained in the CPVC solvents and glues. Presently, states or local jurisdictions comprising over twenty percent of the United States population prohibit the use of CPVC pipe due to concerns about public health impacts.

In 1995, the California Legislature enacted Assembly Bill 151 (Baca) in response to the premature corrosion of metallic plumbing pipe in a number of new residential subdivisions in Southern California due to poor water conditions in these areas. The bill, which became effective on October 12, 1995, authorized cities and counties with corrosive water to allow use of CPVC provided they acted to approve the material prior to January 1, 1996. The bill's exemption from the California Plumbing Code prohibition on use of CPVC potable water pipe expired on January 1, 1998.

Due to the long-standing concerns about drinking water contamination and worker chemical exposures associated with CPVC pipe, the Legislature required that local jurisdictions allowing installation of CPVC pipe pursuant to AB 151 comply with a set of system flushing procedures and worker safety measures specified in the bill. These measures were intended to protect California consumers and workers from the potential health hazards of CPVC installation and use to carry potable water.

Not long after AB 151 went into effect, HCD received reports of widespread non-enforcement of the AB 151 health and safety measures. In response to the reports of non-compliance, HCD issued a formal Information Bulletin on June 17, 1996 to all local building officials restating their statutory responsibility to enforce the health and safety measures specified in AB 151.

In order to assess how effectively the AB 151 health and safety measures were implemented, the California Pipe Trades Council and the Coalition for Safe Building Materials asked Hopcraft Communications to conduct a survey of building officials in the local jurisdictions that allowed CPVC use under the AB 151 authority. To the best of our knowledge, this survey represents the only systematic research effort designed to evaluate the record of compliance with the AB 151 health and safety requirements.

The survey confirms that the widespread non-enforcement of the AB 151 health and safety measures reported early in the implementation of the bill continued throughout the two-year period of AB 151-authorized CPVC installations. The survey results reveal virtually no compliance with the key requirements of AB 151 that were intended to reduce worker chemical exposures during CPVC installation, including protective gloves, ventilation and limitations on dauber size. Similarly, the elaborate flushing procedure required by AB 151 to reduce public exposure to toxic and carcinogenic chemicals in drinking water was almost completely ignored.

It was clear from the interviews with local building officials that this non-compliance with AB 151 requirements was due to the lack of prior responsibility or experience of local building departments with enforcement of these kind of worker safety and drinking water protection measures, as well as a lack of resources or procedures to conduct such enforcement. For example, 84% of the building officials reported that they do not even inspect plumbing systems during installation, which would preclude enforcement of the worker safety measures required by AB 151 during CPVC installation. Most of the building officials indicated that they regarded the AB 151 health and safety measures as the responsibility of the CPVC manufacturers, plumbing contractors or Cal/OSHA.

❒ METHODOLOGY

AB 151 Health and Safety Measures

AB 151 added section 17921.9 to the California Health and Safety Code. Section 17921.9 required "[t]hat all installations of CPVC strictly comply with the interim flushing procedures and worker safety measures set forth in subdivisions (d) and (e)" of the section. A complete copy of section 17921.9 is attached.

The flushing procedures were intended to ensure that the drinking water carried by the pipe did not carry water contaminated by levels of chemicals which present a risk to public health. The flushing procedure required that the completed plumbing system be flushed for one minute or longer at each fixture on the system beginning with the fixture closest to the water meter. The system must be kept filled with water and not drained for one week and then flushed again as described. Before the residence is occupied, the hot water heater must be turned on and the system flushed a third time.

The AB 151 worker safety measures for CPVC pipe installation included requirements that: 1) employers provide education and training and equipment and techniques to reduce worker exposures; 2) cleaning solutions be properly labeled and that primers include proper hazard warnings; 3) applicators and daubers used to apply CPVC glues be limited to small sizes; and 4) workers wear protective, impermeable gloves when installing CPVC pipe. AB 151 also included two safety measures intended to address hazards associated with metal pipe installation: portable eyewash stations for immediate eye washing in the event of splashing of hot flux, and regular maintenance and inspection of acetylene tanks.

Survey Design

Hopcraft Communications designed a telephone survey form to solicit information regarding the implementation and enforcement of the AB 151 health and safety measures by Building Officials in the cities and counties approving CPVC under the AB 151 authority. The form included questions designed to solicit general information regarding the approval status of CPVC within the jurisdiction, the awareness and understanding of the AB 151 health and safety measures and the overall record of compliance with the AB 151 requirements. This general inquiry was followed by questions designed to solicit information regarding implementation and enforcement of the specific worker safety measures regarding worker education and training, limitation on size of applicators and daubers, ventilation of enclosed spaces, utilization of protective, impermeable gloves and provision for portable eyewash stations and maintenance of acetylene tanks. The worker safety enforcement questions were followed by questions regarding implementation and enforcement of the AB 151 flushing procedure.

Survey Implementation

The jurisdictions contacted in the survey were identified from a list prepared by the California Department of Housing and Community Development (HCD) of cities and counties that had notified HCD that the jurisdiction had acted to approve CPVC under the provisions of AB 151. The HCD list included 40 cities and 12 counties, or a total of 52 local jurisdictions that had approved CPVC under AB 151.

The survey was conducted over a four-day period from February 24, 1998 through February 28, 1998. Hopcraft Communications attempted to contact building officials in all 52 local jurisdictions included on the HCD list. Of the 52 building officials on the contact list, 37, or 71% were reached.

❒ SURVEY FINDINGS

Worker Safety Measures

No Enforcement of Requirement that Workers Wear Protective Impermeable Gloves

Not one of the 37 building officials questioned for this survey reported that they enforced the AB 151 requirement that workers were protective impermeable gloves while installing CPVC pipe.

No Enforcement of Requirements for Eyewash Stations and Acetylene Tank Maintenance

Not one of the 37 building officials surveyed reported that they enforced the AB 151 requirements that employers provide portable eyewash stations and regularly maintain and inspect acetylene tanks.

Only One of Thirty-Seven Building Officials Reported Enforcing the Requirement for Ventilation of Enclosed Spaces

Only one of the 37 building officials surveyed reported that he enforced the AB 151 requirement that enclosed spaces be ventilated with portable fans during CPVC installation.

Only One of Thirty-Seven Building Officials Surveyed Enforced Applicator Size Limitation

Only one of the 37 building officials contacted for this survey indicated that he inspected for dauber and applicator size during CPVC installation and enforced the AB 151 requirement that daubers and applicators be limited to small sizes. One other building official reported that he relied on employer education and training to apprise workers of the need to limit dauber size during CPVC cementing. Most other survey respondents demonstrated little awareness of the AB 151 applicator size limitation.

Two out of Five Building Officials Surveyed Enforced Education and Training Requirements

Twelve of the building officials questioned for this survey reported that they rely on employers to provide the education and training materials and instruction required by AB 151, representing 32% of the survey respondents. Four building officials indicated that they provided additional brochures, mailings or other education and training materials. (Although Hopcraft Communications requested sample copies of such supplemental materials, no materials were provided). Thus, a total of 43% of the respondents reported some effort to comply with the AB 151 education and training provisions.

Drinking Water/Public Health Measures

Only Two of Thirty-Seven Building Officials Surveyed Enforced Flushing Requirements

Only two of the 37 building officials surveyed reported that they required compliance with the plumbing system flushing requirements set forth in AB 151, representing 5% of the survey respondents.

General Awareness, Inspection and Record-Keeping

Almost All Building Officials Reported Some Awareness of the AB 151 Health and Safety Measures

Thirty-six, or 92%, of the respondents reported general awareness of the AB 151 worker safety and drinking water protection measures. Three of the building officials contacted reported that they were unaware of the AB 151 requirements for CPVC installation.

Four Out of Five Building Officials Do Not Inspect Plumbing Systems During Installation, Precluding Enforcement of AB 151 Worker Safety Measures

Thirty-one, or 84%, or the building officials surveyed reported that they do not inspect any plumbing system during installation, but only check the completed system for compliance with plumbing code requirements. Given this practice, it is impossible for these building officials to enforce compliance with most of the installation requirements established by AB 151, which require site inspection during installation.

Eight, or 20%, of the respondents reported some effort to inspect for compliance with the AB 151 requirements. As reported, above, however, when questioned regarding enforcement of the specific AB 151 measures (e.g., protective gloves, ventilation, etc.), these same building officials indicated that they did not inspect for compliance with these requirements.

No Building Officials Keep Inspection Reports or Other Records of Compliance With AB 151 Health and Safety Measures

None of the building officials surveyed indicated that they maintained any inspection reports or other records of compliance with the AB 151 worker safety or flushing requirements.

DECLARATION OF ROBERT J. CALONE REGARDING INVESTIGATION OF COMPLIANCE WITH CPVC MITIGATION REQUIREMENTS

I, Robert J. Calone, do declare and if called as a witness would testify as follows:

1. I am a certified plumbing inspector. I have over 31 years of experience as a plumber and 11 years of experience as a general superintendent. I have also been a plumbing instructor at the apprenticeship school for over 20 years.

2. On Friday, March 25, 2005 I spent the day at the town of Discovery Bay. I visited two subdivisions and a custom home that were installing CPVC drinking water pipe.

3. I interviewed seven workers at the two subdivisions and asked them what safety measures they were using:

a.	Wes	cotton glove, no eye protection
b.	Tom	cotton glove with rubber palms, no eye protection
c.	Darren	surgical gloves, no eye protection
d.	Mike	no gloves and no eye protection
e.	Chris	no gloves and no eye protection
f.	Rod	no gloves and no eye protection
g.	Robby	no gloves and no eye protection

4. I interviewed one worker named Rick at the custom home, who was using nitrite gloves and goggles. I asked him why they were using the correct safety equipment. He said one of his fellow workers had received an eye injury and, after the accident, they implemented the proper equipment.

5. I did not observe any ventilation or breathing equipment in use on the site, but none of the workers that I observed were working in a confined space.

6. I also interviewed some journeymen at the Union Hall on Wednesday, March 16, 2005. I asked them what sort of safety protection they used when installing CPVC pipe. They answered as follows:

a. John said he hadn't used any protection at all. I asked why he didn't use any eye protection, gloves or breathing equipment and he replied that no one had told him of the importance until I talked to him.

b. Robert said he used safety glasses and cotton gloves.

c. Kevin said he used PVC cotton-lined gloves and goggles. He also said that he did not use any breathing equipment when installing CPVC in a closed room even though he knew that he should have used it.

7. Most of the workers and journeymen who I spoke with were not aware of the safety measures needed to install CPVC and even those who were aware of the measures did not necessarily follow the measures.

8. I also asked the finish workers at the two subdivisions to describe to me their flushing procedures. They informed me that they run the water on the fixtures while they are testing the fixtures but neither indicated a time frame. I asked them if they had tagged any of the fixtures stating that a seven-day static flush was in place and they said no. Upon further inspection of the buildings, I found no fixture tagging.

9. In the areas of safety and flushing I have found that there is generally non-compliance with the standards. At a minimum, more work is needed to educate the workers on safe practices and the inspection departments need to more strictly enforce the flushing and safety procedures.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and that this declaration was executed on this 8 day of April 2005.

Robert J. Calone 4/8/05

Robert J. Calone
Certified Plumbing Inspector
#016380

Jim Bellows, CIH, CSP 5000 Manila Avenue, Oakland, California 94609 510.654.6787

August 27, 1998

Daniel L. Cardozo
Adams, Broadwell, and Joseph
651 Gateway Boulevard, Suite 900
South San Francisco, California 94080

Dear Mr. Cardozo:

Attached are my comments on the "Draft Environmental Impact Report for CPVC Pipe Use for Potable Water Piping in Residential Buildings" (DEIR) recently produced by the California Department of Housing and Community Development. At your request I have reviewed the worker health and safety elements of the DEIR, and my comments address their technical accuracy and validity.

I appreciate the opportunity to participate in reviewing the DEIR. As the lead investigator for a 1989 Department of Health Services study of health hazards associated with CPVC pipe installation, I focused particular attention on whether that study's findings were interpreted appropriately and whether the data from that study were used in the DEIR to fully and accurately inform the policy making process. In some cases the DEIR's interpretations and applications of our 1989 data were inappropriate; my comments outline these areas and indicate the appropriate interpretations.

In addition to reviewing the DEIR itself, I have also reviewed numerous source documents on which the DEIR is based and I have reviewed other materials relevant to the issues presented. Among these were the earlier DEIR and Administrative Final EIR prepared by the Lead Agency during 1989-1990. In some cases, I drew upon my exposure data files from the 1989 DHS study to perform additional analyses.

In my professional opinion, the findings of the current DEIR are not consistent with available data and with established practices of industrial hygiene and health risk assessment. The "significance thresholds" on which the findings are based are fundamentally flawed. The DEIR in many instances bases its findings on misrepresentations, incorrect assertions, and invalid interpretations.

Workers installing CPVC potable water pipe can be expected to regularly experience exposures in excess of established exposure limits. Such exposures can

be expected under conditions of normal use. Exposures will not uncommonly be in the range previously associated with adverse health effects in humans and with cancer in laboratory animals. These exposures, and their potential health effects, must be considered significant.

Safety recommendations on material labels cannot be expected to prevent overexposures. A combination of specific, focused hazard reduction measures should be developed and implemented to prevent overexposures and adverse health effects.

The DEIR must be revised to correct the numerous errors and misleading interpretations, to fully account for the significant impacts that can be expected, and to incorporate appropriate mitigation measures. Any revisions should be carefully scrutinized to assure that the critical errors have been corrected.

My detailed comments, analyses, and conclusions follow. My *curriculum vitae* is also attached.

Sincerely,

Jim Bellows, CIH, CSP

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE
INCORPORATED
CERT. NO
5097
EXPIRES
12-31-1998
PENNSYLVANIA 1960
JIM BELLOWS, CIH

Comments on the Draft Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings

Based on a thorough review of the "Draft Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings" (DEIR), along with supporting documents and other relevant materials, my analysis, comments, and conclusions are as follows.

1. The DEIR's significance thresholds are fundamentally flawed and do not provide meaningful criteria for the existence of significant impacts.

Establishing meaningful significance thresholds is critically important in the process of evaluating the project's potential to cause serious adverse impacts. In this context, a significance threshold could be considered "meaningful" only if an impact that is expected to cause significant adverse health effects is also one that exceeds one or more established "thresholds of significance." Available data and scientific analyses are used to characterize the impacts that can be expected if the project is approved, and the significance thresholds provide a test of whether those expected impacts are significant. Without significance thresholds that establish meaningful criteria, no amount of data or analysis will produce a valid conclusion.

Future risks to human health are assessed by collecting data on the extent of exposure to a particular hazard (or hazards) and studying the relationship between exposure and health effects in exposed populations or in laboratory animals. Then expected future exposure levels are compared with those found to adversely affect health.

The "exposure" means, in the case of a toxic chemical, the concentration in the environment. The exposure determines the "dose" (the amount absorbed from the environment) and is itself determined by the conditions under which the chemical is used. Assessment of exposure (or dose) is of fundamental importance in the overall risk assessment process because virtually all chemicals – including water and oxygen – are toxic in sufficiently high concentrations, while virtually all have negligible toxicity at sufficiently low concentrations. The principle that the dose determines the frequency and severity of health effects is captured

in the phrase "the dose makes the poison," and is elaborated in some detail in the DEIR's Appendix.

In the area of worker health and safety, the DEIR establishes the following significance thresholds:

- Regularly exceeding established workplace standards by persons following material labels and Material Safety Data Sheets, documented in worker health and safety studies, for example the 1980 and 1989 California Department of Health Services reports.

- Workplace hazards, for which substantially more severe adverse health and safety impacts and substantially greater safety precautions are identified on the Material Safety Data Sheets for CPVC related materials, or published data compared to materials used for existing pipe materials.

- Other information conclusively demonstrating that the use of CPVC pipe for potable water piping would result in adverse health or safety consequences to workers which would not be avoided or mitigated to insignificance by following the safety recommendations on the material labels or Material Safety Data Sheets.

The DEIR's significance thresholds depart from established principles and techniques for incorporating industrial hygiene into the overall risk assessment process. They neglect the fundamental importance of exposure levels; they are not based on expected conditions of use; they base risk comparisons on inappropriate indicators of health risk; and they set unrealistic standards of evidence. The significance thresholds do not provide meaningful criteria, in the sense that the thresholds would not be exceeded *even if the project were expected to result in significant adverse health effects among affected workers.*

Note that the second significance threshold is based entirely on a comparison between the risks presented by CPVC pipe installation and the risk associated with installing conventional materials such as copper pipe. The appropriateness of this comparison in the CEQA context is a legal matter, which is beyond the scope of these comments. My conclusion that the second significance threshold is fundamentally flawed is based other factors. To the extent that the comparison between CPVC and existing materials is inappropriate, the second significance threshold fails even more completely to provide a meaningful standard for the significance of expected impacts.

a. *The second significance threshold disregards the critical importance of exposure levels in assessing the potential for adverse health effects.*

Exposure levels were the primary focus of the 1989 DHS study,[1] and the importance of considering exposure levels when evaluating expected health impacts is the primary focus of these comments. The DEIR fails to adequately consider exposure levels throughout the worker health section, and in fact does not present any worker exposure data anywhere in the body of the DEIR. This failure to consider exposure levels is reflected even in the central reasoning of the DEIR, including the second "significance threshold".

The second significance threshold is based on a comparison of the health effects data for CPVC primers and cements with the health effects data for copper solders and fluxes. The health effects data to be compared are from the Material Safety Data Sheets (MSDSs) or "other published data."

Every MSDS is required to include a summary of health effects associated with overexposure,[2] and many offer a good (if brief) summary of published health effects information. However, the health effects data on MSDSs are without regard to specific exposure levels.[3] This is perhaps sensible, given the intended uses of MSDSs. The author of an MSDS has no knowledge of the conditions under which a material may be used, nor of the resulting exposure levels, and must therefore warn the user of any possible health effects. However, limits the value of MSDSs for determining the health effects that can be expected under specific conditions of use, and renders them useless for comparing the health effects that can be expected under alternative exposure scenarios.

Comparing the expected health impacts of two alternative exposure scenarios by comparing the MSDS health effects summaries can result – at best – in an unsubstantiated conclusion. At worst, it can result in a completely incorrect conclusion. Consider as an example a hypothetical project that would increase by ten-fold the exposures to some toxic agent and would increase ten-fold the incidence of a serious illness. Such health impacts would be judged significant by any reasonable measure, but the DEIR's second significance threshold would not be exceeded because the MSDS health effects summary would be unchanged.

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[1] Bellows, et al., 1989; California Department of Health Services.

[2] In California, this requirement is in 8 CCR §5133.

[3] MSDSs also indicate legal and recommended exposure limits, but do not relate health effects to these or other exposure levels.

Consider another comparison between two hypothetical exposure scenarios: in one alternative, exposures to some toxic substance are virtually certain to cause numerous serious illnesses, while in the other alternative people would be exposed to a different substance that is fatal at high concentrations but harmless under the conditions of expected use. A comparison of MSDSs would indicate that the second alternative had more serious health impacts, while in reality the opposite were true. Whether or not this hypothetical example is relevant to the comparison between CPVC and copper piping depends critically upon the exposure levels as well as the toxicity of the materials used. Relevant exposure data are presented later in these comments but were omitted from the DEIR.

b. The second significance threshold incorporates an unreasonable assumption that the recommended safety measures are a meaningful indication of the degree of hazard presented.

The second significance threshold also involves comparison of the recommended safety precautions for CPVC- and copper-related materials. This comparison reflects an assumption that materials expected to cause more frequent or more severe health effects would be labeled with "substantially greater"[4] safety precautions.

In fact, there exist only a small number of feasible hazard control recommendations to control an enormous variety of hazardous exposures. "Use only with adequate ventilation"[5] is the boilerplate recommendation for an enormous variety of inhalation hazards, from mild to severe. Such a general precaution gives no indication whether "adequate ventilation" means an open window or a sophisticated, engineered exhaust ventilation system. Similarly, "use rubber gloves" can be used as a boilerplate recommendation for either mild or severe dermal hazards.

Similarly-worded safe use precautions do not provide a reliable indication that two hazards are similar in severity, nor that the two hazards have a similar probability of producing adverse health effects.

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[4] DEIR, p. 44.

[5] DEIR, p. 45.

c. *The first and third significance thresholds disregard the working conditions, exposures, and health effects that can be expected if the project is approved.*

The first and third significance thresholds address exposure levels and conditions of use, but they exclude consideration of significant exposures that were documented in the DHS 1989 study and can be expected to occur in the future.

Meaningful assessment of future health impacts must be based on exposures that are expected to occur. Several approaches are accepted practice in public health risk assessment. In the simplest approach, average or most-likely exposure levels are determined, and the health risks associated with those exposures are assessed.[6] In a rather different approach, various categories or types of exposures are defined. The number of people in each category is estimated, the health risks associated with each exposure category are assessed, and the overall impact on the affected population is calculated by adding together the expected health effects in each category.

The DEIR does not adopt either of these accepted approaches. Instead it essentially creates a variant on the second approach. The DEIR explicitly establishes one exposure category (exposures to "persons following material labels and Material Safety Data Sheets"[7]) and implicitly establishes a second category (exposures to persons not following material labels). The first and third significance thresholds then exclude from consideration exposures and resulting health effects to persons not following material labels.

This approach is essentially the one taken by Robert Tardiff, cited by the DEIR, in his comments in defense of CPVC. Tardiff categorizes work practices as "proper" vs. "improper", then downplays the significance of health effects attributable to "improper" work practices.[8]

The DEIR's exclusion of exposures and health effects to persons not following material labels is central to its conclusions, and must be explored in some detail. Logical analysis indicates that exposures to persons not following material labels will be insignificant if the number of such people is insignificant, or

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[6] Alternatively, data can be used to calculate both the average and the variance of exposure levels, or other distribution parameters, and these in turn used to estimate the percentage of exposures that exceed a particular level.

[7] DEIR p. 43, first significance threshold.

[8] Comments of Robert Tardiff, 1997.

if the exposures and resulting health effects among such people are insignificant. Excluding these exposures from consideration implies a belief by the Lead Agency that at least one of these conditions is true. In other words, the first and third significance thresholds imply either that all workers will follow the material labels, or that "significant" heath impacts are not expected even among workers who do not follow material labels, or both. Each proposition will be examined.

i. Safety recommendations on material labels and Material Safety Data Sheets are too vague to reliably affect work practices.

Many workers observed during the 1989 DHS study were engaged in high-exposure practices such as installing CPVC pipe in enclosed areas without mechanical ventilation, having extensive skin contact with CPVC primers and cements, or working near spilled CPVC primers and cements. These activities were contrary to recommendations on the material labels at the time, yet they were relatively common. The reasons these particular safety recommendations were not implemented have not been studied.

Health educators in a wide variety of comparable situations have documented many factors that contribute to the ineffectiveness of health recommendations, including: vague recommendations that do not point to specific action, boring and repetitive messages, lack of definitive consequences to ignoring the recommendations, lack of positive incentives to follow recommendations, and lack of supplemental or follow-up activities. Each of these applies to the recommendations on CPVC primer and cement labels, and to my knowledge none have changed significantly since 1989.

Absent any documented changes in installation practices, and absent any changes in material labeling, worker safety training, OSHA regulations and enforcement, or other factors that could change installation practices, plumbers' work practices must be expected to be unchanged. Based on the findings of the 1989 DHS study relied upon by the DEIR, it must be anticipated that a significant percentage of plumbers will install CPVC pipe in enclosed areas without mechanical ventilation, will have extensive skin contact with CPVC primers and cements, or will work near spilled CPVC primers and cements. If expanded use of CPVC pipe is approved, the number of people engaged in these activities can be expected to expand similarly.

This observation was the subject of strong comments from the State's own health experts in response to an earlier Draft Environmental Impact Report. In 1990, Richard Jackson, MD, Chief of the Office of Environmental Health Hazard Assessment, commented: "Unless HCD devises specific, effective implementation proposals, the hazard control recommendations included in the

[1989] DEIR should not be expected to have much real impact on working conditions or exposure levels."[9]

The Lead Agency apparently understood and acknowledged this point years ago. The 1990 Administrative Final EIR addressed the recommendations of Dr. Jackson and others by proposing specific mitigation measures designed to reduce worker exposures. Specifically, the earlier Administrative Final EIR included statements such as,

> "HCD will work with Cal/OSHA to define a means to ensure that employer education and training programs are in place,"
>
> "issuance of building permits could be made contingent on evidence that the contractor has an approved health and safety plan in place,"
>
> HCD "will work with Cal/OSHA to increase enforcement of ventilation requirements" and to produce a "comprehensive alert," and
>
> HCD will "[r]equire the use of protective gloves on the work site when significant chemical exposure may occur... HCD will request that Cal/OSHA remind employers of their responsibility and increase attention to enforcement of the protective requirement, including the provision of eyewash facilities. It will also require that instruction in their use be part of all education and training. Finally, HCD will work with Cal/OSHA and DHS to verify that suitable protective gloves are available."[10]

In the 1989-1990 environmental review process, the Lead Agency found that such measures were "essential if plastic pipe is to be used safetly."[11] Absent specific measures such as these, work practices cannot be expected to be safer than those documented in 1989, and exposures cannot be expected to be lower.

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[9] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment.; p. 3.

[10] 1990 Administrative Final EIR, pp. 79-81.

[11] 1990 Administrative Final EIR, p. 79.

ii. Vaguely-worded safe use recommendations may actually result in exposures being increased rather than controlled.

Vague safety recommendations can, at worst, be counterproductive. A classic example is that use of ineffective gloves – permeable to a toxic substance of concern – may inadvertently lead to increased dermal absorption. Workers wearing ineffective gloves may acquire a false sense of security, and adopt practices that produce heavy contamination of their gloves. Dermal exposure would occur when material permeated or penetrated through the gloves, and could be greater than if the material had been handled carefully without gloves. In some cases, ineffective gloves that allow permeation or penetration of toxic materials may function to hold these materials in intimate contact with the skin, increasing the quantity absorbed.

iii. Overexposure of some workers may result from others' inability to follow safe use recommendations.

Plumbers and other construction workers typically work in small crews, in close proximity to others. The 1989 DHS study found that "exposures were significantly higher when workers had secondary exposure from other workers cementing nearby."[12] This finding indicates that workers could experience significant health effects attributable to spills or excessive primer and cement usage by others.

More importantly, many of the key safe use recommendations are under the control of employers, not individual workers. For example, individual workers typically have little control over whether the plumbing is installed early in a construction project or after the spaces have been enclosed. Individual workers similarly have little control over the primers and cements used, the availability and use of mechanical ventilation, the presence of other workers installing other plastic piping systems nearby, or the availability of facilities for safely decontaminating skin and eyes. Thus, workers' exposures – and overexposures – depend critically on the actions of their employers.

Thus, even assuming health effects could "be avoided or mitigated to insignificance by following the safety recommendations,"[13] the problematic work practices will often be beyond the control of those affected. High exposures can be expected – even among workers implementing the safety recommendations

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[12] Bellows, et a., 1989; p. 19.

[13] DEIR, p. 43.

over which they have personal control – because of the actions of others. Based on the findings of the 1989 DHS study, these exposures could result in potentially significant health effects.

iv. Exposures capable of significantly affecting human heath must be considered "significant" impacts, even if they are associated with failure to follow material labels.

These comments elsewhere review in detail the evidence that CPVC pipe installers will periodically experience high solvent exposures, and that these exposures can be expected to produce health effects. Data from the 1989 DHS study indicate the highest exposures are produced by work practices contrary to manufacturers' recommendations.

In analyzing the DEIR's significance thresholds, it is most relevant to note that both the DEIR and the State's own health experts acknowledge that adverse health effects can be expected among workers not following material labels. In advising the Lead Agency on preparation of the current DEIR, DHS wrote: "Case reports point to the likelihood that overexposure related to poor ventilation has already led to illness in pipe workers."[14] The DEIR itself states: "Workers not following safe use recommendations or using improper materials can be injured, and the Lead Agency considers this to be the worst case situation."[15]

In acknowledging that exposures to persons not following safe use recommendations can cause injury or illness, but establishing a significance threshold that excludes these exposures from consideration, the DEIR implies that injury to such persons is somehow not "significant" in this policy making context. Apart from any legal issues created by this approach, this exclusion is completely contrary to accepted public health practices and to established policy making in other contexts. Indeed, most major public health programs – from AIDS prevention through tobacco control to traffic safety – are explicitly directed toward limiting the health consequences of people's inability to consistently follow safety recommendations. Policy makers in these contexts accept the reality that people cannot be expected to follow all safety recommendations, and that warnings alone cannot be expected to provide sufficient protection.

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[14] Comments of Elizabeth Katz, MPH, Acting Chief, Hazard Identification System and Information Service, Department of Health Services; June 11, 1998.

[15] DEIR, p. 69

v. Excluding consideration of exposures and adverse health effects resulting from inability to follow safe use recommendations departs from the Lead Agency's past practices and from the advice of State health experts.

The Lead Agency recognized as early as 1988 the importance of identifying health impacts under the conditions most likely to occur if expanded use of CPVC were approved. This recognition was the basis of the Lead Agency's request that DHS study exposures under real-world conditions. The approach of studying real-world conditions was supported by DHS and by representatives of workers and CPVC manufacturers. There would have been no need for such a study if policy making could be based on arbitrarily categorizing work practices as "proper" vs. "improper", then discounting any impacts attributable to "improper" work practices.

DHS reminded the Lead Agency to consider all expected conditions and exposures in its 1990 comment, "In the absence of specific, effective implementation strategies, HCD must give much more serious consideration to the worker exposures, and possible health risks, likely to occur with increased use of plastic pipe."[16]

The Lead Agency acknowledged this advice in its 1990 Administrative Final EIR, which included several specific mitigation measures intended to decrease the prevalence of unsafe work practices. During preparation of the current DEIR, DHS once again reminded the Lead Agency to base its analysis on expected conditions, commenting that expanded use of CPVC "is a question involving substitution of chemicals and work methods. Such substitutions occur in a context of real-world alternatives."[17]

vi. To provide a meaningful standard for the project's potential to cause significant adverse health impacts, the significance thresholds must be revised to reflect the real-world conditions that can be expected, and their potential health impacts.

The DEIR's first and third significance thresholds imply either an expectation that safe use recommendations will be implemented in the future, or a belief that adverse health effects attributable to unsafe practices are not

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[16] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 3.

[17] Comments of Elizabeth Katz, MPH, Acting Chief, Hazard Identification System and Information Service, Department of Health Services; June 11, 1998.

"significant" in policy making. Both are contrary to available data and established practices. The significance thresholds therefore do not provide meaningful criteria, in the sense that the thresholds would not be exceeded even if the project were expected to result in significant adverse health effects among affected workers. The significance thresholds should be modified to reflect the expected conditions of use and the associated exposures and health effects.

d. *The third significance threshold sets an unreasonable standard ("conclusively demonstrating") for the finding of a significant impact.*

The DEIR's third significance threshold sets a high standard for evidence of significant impacts: "Other information conclusively demonstrating that the use of CPVC pipe for potable water piping would result in adverse health or safety consequences to workers, which would not be avoided or mitigated to insignificance... " In other words, exceeding this significance threshold would require a conclusive demonstration that some particular levels of exposure would be experienced by plumbers installing CPVC pipe, and a conclusive demonstration that these exposure levels would not be mitigated by non-specific safe use recommendations, and a conclusive demonstration that the exposures could result in adverse health effects.

The first element (conclusive demonstration that high exposures would occur) requires a level of certainty about future events that seems unachievable on its face, but this is perhaps a legal issue and is not considered further in these comments. The second element (conclusive demonstration that exposures could not be mitigated by safe use) is tautological: the boilerplate recommendation "use only with adequate ventilation" is worded so broadly as to guarantee that any exposure causing adverse health effects was the result of failure to the recommendation. Again, this is perhaps a legal issue and is not considered further in these comments.

The possibility of meeting the third test – "conclusively demonstrating" any causal relationship between exposure and health effects – is a scientific matter that merits further consideration. In general, a causal relationship may be conclusively demonstrated only if all the following prevail: the health effects of interest are readily identifiable, the health effects are manifest at a predictable (and usually short) period after exposure, a high percentage of exposed individuals experience the effects of interest, and a low percentage of unexposed individuals experience the effects. Many exposure-response relationships meet all these conditions, and the causal relationships can be demonstrated quite conclusively using the analytic techniques of medical toxicology and epidemiology. For example, there is no apparent disagreement with the findings that (if the concentrations are sufficient) acetone exposure causes central

nervous system depression, exposure to copper fumes causes "metal fume fever," and tetrahydrofuran causes severe corneal irritation; these exposure-response relationships can be said to have been "conclusively demonstrated."

For other types of health effects – those that do not meet the conditions listed previously – the prospects for "conclusive demonstration" of a causal relationship are remote, simply because the available analytic techniques are not sufficient to provide this level of evidence. Cancers are the best-known example; their causes are notoriously difficult to pinpoint because a long and variable latency period separates exposure from the appearance of disease. Even in the case of cigarette smoke – with hundreds of millions of people exposed and tens of millions of cancer deaths – dozens of studies over several decades were required before the relationship between smoking and lung cancer was conclusively demonstrated.[18]

Cancers are only the best-known example of health effects whose causes are difficult to conclusively demonstrate. Similar difficulties are presented by many other types of exposure-effect relationships, such as: chronic neurologic impairment caused by solvent exposure (because characterizing the health effects is difficult), hypertension caused by lead exposure (because the condition is often not identified until after exposure has ceased), occupational asthma (because many exposed individuals are unaffected), spontaneous abortions caused by glycol ethers (because many unexposed individuals are affected), and chemically-induced birth defects (because the timing of exposure is critical).

Epidemiology is the only scientific discipline capable of demonstrating causation for conditions such as those listed in the previous paragraph. However, epidemiology can provide evidence that approaches the level of "conclusively demonstrating" exposure-response relationships only if the presence or absence of the illness can be clearly established, exposures are determined accurately, a large number of people have been affected, and multiple systematic studies have been conducted. These conditions are extremely restrictive, and they account for the very small number of cases in which epidemiology can be said to have "conclusively demonstrated" an exposure-response relationship. Of the exposure-response relationships listed in the previous paragraph, many are widely accepted but could not be described as "conclusively demonstrated."

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[18] Some people still do not accept that the role of cigarette smoke in causing lung cancer has been conclusively demonstrated, and cigarette smoke's role in causing cancer at several other sites is still uncertain.

Because the third significance threshold relies on the standard of "conclusively demonstrating" an exposure-response relationship, and because this level of evidence is essentially unachievable for many adverse health effects, there is effectively no possibility that exposures causing these health effects could trigger a finding of significance. In incorporating such a strict level of evidence in the significance threshold, the Lead Agency has either disregarded the inherent limitations of epidemiology or has intentionally excluded consideration of a wide class of adverse health effects.

The standard of "conclusively demonstrating" adverse health effects is inconsistent with public health practice and with the limitations of epidemiology and risk assessment, and the third significance threshold must be revised if it is to provide a meaningful test for the significance of expected impacts.[19] A more realistic standard of evidence is incorporated in the first significance threshold: "documented in ... studies." A comparable standard should be used in the third significance threshold.

e. Conclusion regarding significance thresholds

The significance thresholds are inconsistent with established risk assessment and public health practice, incorporate assumptions that cannot be supported by facts or analysis, and disregard the earlier recommendations of the State's health experts. The significance thresholds must be revised if they are to provide a meaningful standard for the significance of expected impacts. Findings based on the significance thresholds must be considered invalid unless the significance thresholds are modified substantially.

2. The DEIR's finding of no significant impacts on worker safety is not supported by any data or scientific analysis, and is based on several misrepresentations, incorrect assertions, and invalid assumptions.

The DEIR – after presenting fundamentally flawed significance thresholds – summarizes some information on the potential impacts of CPVC installation, adds its own assumptions, assertions, and interpretations, and combines these to reach the conclusion that expanded use of CPVC would not result in significant impacts to worker health and safety. Many of the assumptions, assertions, and interpretations are misleading, unsupported, invalid, or factually incorrect.

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[19] The DEIR in other sections also applies similarly unrealistic standards of evidence. See for example, on page 47: "There is still no information *proving* adverse health effects from long-term exposures... " (emphasis added).

a. *The DEIR's use of conclusions from a 1980 report is misleading because that report was written nine years before key data were available.*

The DEIR quotes directly from the conclusion of a 1980 DHS report on health effects related to plastic pipe.[20] Perhaps the Lead Agency found it preferable to quote this report rather than the later and much more comprehensive 1989 DHS report because its conclusions are more favorable to the proposed project. However, this use of the 1980 conclusion is misleading and inappropriate. The 1980 DHS report was not able to draw on any extensive exposure data, because none had yet been produced.

The passage quoted refers to "field measurements of exposure under a wide range of working conditions," but in fact the exposure data available in 1980 was rather limited. The experience of the 1989 study team was that monitoring exposure under a wide range of conditions required extraordinary effort and expense, especially because the activity of greatest interest (installation of CPVC potable water pipe for residential use) was generally not permitted in the state. Studies prior to the 1989 DHS study did not identify, locate, or monitor the wide range of working conditions monitored in 1989.

Conclusions drawn from earlier studies, which drew on only a small portion of the exposure data now available, are irrelevant given current information. Quoting these conclusions is misleading, unless the quote is to provide historical context.

Curiously, the body of the DEIR does not quote directly the conclusions of the more extensive and more relevant 1989 DHS study. The most relevant conclusions of that study describe the full range of exposures documented, including:

"1. Short-term exposure limits for THF, and for the additive effects of THF, MEK, CHX, and ACE [tetrahydrofuran, methylethylketone, cyclohexanone, and acetone], are sometimes exceeded during routine residential plastic pipe installation. The probability of exceeding the short-term exposure limits at least once in a work day is dependent on working conditions and is highest for workers installing CPVC potable water pipe; for these workers, this probability is estimated to be 68%.

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[20] DEIR, p. 44.

"2. ... full shift overexposures occur on some work days. Full-shift overexposures are most likely to occur during CPVC-pw [potable water] installation, in which the probability of overexposure is estimated to be 10%."

and

"5. Dermal absorption of THF probably contributes significantly to the total (airborne plus dermal) exposure of workers who have heavy skin contact with primers and cements. Based on their urine THF concentrations, four of these workers had estimated equivalent airborne exposures ranging from 150 to 740 ppm. Despite the uncertainty of these estimated values and the lack of chronic toxicity information, these data are of concern because they suggest that for some workers, total exposure may far exceed the airborne exposure limit."[21,22]

These conclusions must be cited directly if the DEIR is to provide an accurate indication of DHS findings in its extensive 1989 study.

b. The DEIR's interpretation of the 1989 DHS study misrepresents the study's stated conclusions, and misrepresents the importance of the study in understanding the exposures that can be expected if expanded use of CPVC is approved.

The DEIR describes briefly the 1989 DHS study, and paraphrases key findings of the study as follows: "Some potential for short-term and long-term overexposure to solvents was found."[23] That paraphrase badly misrepresents the actual conclusions quoted previously.

The 1989 DHS study did not find "potential" for overexposures; it documented *actual* overexposures during conditions of normal use. Short-term exposures to THF were up to 529 ppm, more than twice the exposure limit. The study found that short-term overexposures were not uncommon, and estimated that they were likely to occur in over two-thirds of work days when CPVC is being installed.

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[21] Bellows, et al., 1989; p. 33.

[22] Note that significant new data on chronic toxicity of THF have become available since the 1989 DHS report. The conclusions of the 1989 report are quoted because they are still the best available summary of exposures expected during installation of CPVC piping. The 1989 report's conclusions regarding the potential for adverse health effects are no longer accurate because they do not reflect current toxicity information.

[23] DEIR, p. 45. The DEIR does provide on p. 47 a somewhat more accurate paraphrase of DHS' 1989 findings.

The DEIR also misrepresents the conclusions of the 1989 DHS report by failing to mention a key conclusion: that dermal absorption contributes significantly to total exposure for some workers, and that for these workers the total exposure may "far exceed" the airborne exposure limits. Selective omission of key results does not meet recognized standards for fair and honest presentation of scientific data.

The DEIR largely dismisses the 1989 DHS conclusions, by pointing out that many workers studied did not follow safe use recommendations. The fact remains that the 1989 DHS study is the best available determination of exposures under a wide range of real-world working conditions, and is therefore the best available indication of exposures that can be expected if expanded use of CPVC is approved. Note again the DHS comments on the 1989 DEIR, that absent effective mitigation measures "the hazard control recommendations included in the DEIR should not be expected to have much real impact on working conditions or exposure levels." The 1990 Administrative Final EIR found that such measures were "essential."[24]

Regular overexposures were documented in the 1989 DHS study, and absent evidence of changes since that study was conducted, regular overexposures must be expected if expanded use of CPVC is approved.

c. *The DEIR's statement that technological advances since the DHS study have reduced exposure levels is not based on data or analysis; and assertions and inferences offered in support of this statement are incorrect.*

The DEIR focuses substantial attention on changes since the 1989 DHS study. Any significant changes are indeed a legitimate subject of consideration. Changes in materials or working conditions could certainly change exposure levels, and could decrease (or increase) the potential for significant adverse health effects. The changes produced by new materials or working conditions could be documented by collection of new data, or could be estimated using scientific models or evidence-based analysis. However, the DEIR cites neither data nor rigorous analyses in claiming, "Measures which would greatly reduce the likelihood of exceeding the standards were implemented prior to the beginning of preparation of this EIR."[25]

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[24] 1990 Administrative Final EIR, p. 79.

[25] DEIR, p. 47.

The DEIR does cite several "changes" since the 1989 DHS study. Each of these merits consideration.

i. The DEIR's statement that dyes have been added to solvent primers, with the intent of discouraging dermal exposure, is factually incorrect.

The DEIR asserts that "consistent with the recommendations of the DHS report, dyes have been added to the formulae for solvent primers."[26] No substantiation is offered for this assertion. More importantly, the assertion is factually incorrect. I reviewed the CPVC primer and cement product descriptions and MSDSs of two major manufactures.[27] Both manufacturers offered CPVC primer in either dyed or clear formulations. In other words, the situation is unchanged from 1989: some primers are dyed and others aren't. No changes in working conditions or exposures can be expected.

ii. The DEIR's assertion that one-step cements would eliminate the need for adding dyes to CPVC primers is unsubstantiated and is not consistent with observations of the 1989 DHS study.

The DEIR claims that "while dyes are desirable, the one-step cements would obviate the need for this measure."[28] This claim is not supported by any substantiation or any analysis. During the 1989 study, several workers used primers to remove cement residue from their skin. This practice was contrary to safe use recommendations on the material labels.

Based on my conversations with workers, my understanding is that they used primers for this purpose because they were unskilled in keeping cement off their skin, they disliked the process of peeling cement residue from their skin, the primer is formulated to be an ideal solvent for the residue, and the primer is readily available. Of these, introduction of one-step cements would have no impact on the first three, and would have minimal effect on the availability of primers unless all primers were removed from the market. So long as undyed primers are available for drain, waste, and vent lines (DWV), irrigation, fire sprinkler systems, and the like, plumbers who like to use them as a hand cleaner must be expected to continue this practice.

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[26] DEIR, p. 46.

[27] The manufacturers were Oatey and IPS. The product descriptions and MSDSs were readily available to the Lead Agency.

[28] DEIR, p. 46.

iii. The DEIR implies incorrectly that safety recommendations on material labels have changed.

The DEIR includes in a list of technological changes a statement that "instructions consistent with DHS recommendations to reduce exposures are now on the material labels."[29] This statement, and its placement in a list of recent changes, imply that safety recommendations on material labels have changed since the 1989 DHS study. The DEIR offers no substantiation. To my knowledge, the material labels typical of these products have remained essentially unchanged since the 1989 study (and before).[30] No changes in work practices or exposure levels can be expected.[31]

d. The DEIR's assertion that use of low-VOC primers and cements will reduce worker exposures is not substantiated by any data or analysis; an evidence-based analysis indicates it is incorrect.

The DEIR asserts that introduction of low-VOC primers and cements will reduce the exposures associated with CPVC pipe installation.[32] This point receives the greatest emphasis in the Lead Agency's assertion that technological changes since 1989 would reduce exposure levels. The claim is not substantiated by any data or any scientific analysis.

The 1989 DHS study was specifically designed to help policy makers evaluate exposure scenarios other than those actually monitored. The study report presents data and an exposure model ideally suited to estimating the exposures that can be expected under modified conditions, such as with alternative primers and cements. The analysis is as follows.

The 1989 study proposed and tested the exposure model:

$$c_i = \frac{k_N N^{b_N} \times k_B B_i^{b_B} \times k_T T^{b_T}}{k_V V^{b_V}}$$

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[29] DEIR, p. 46.

[30] Comparison based on current labels and the label language quoted in Bellows, et al., 1989, p. 14.

[31] Safe use recommendations on material labels were not implemented in 1989, so no substantial changes in work practices would be expected even if modest changes were made in material labels.

[32] DEIR, p. 48, and implied on pp. 45, 112.

where c_i is the airborne concentration (or exposure) of some substance i, B_i is the bulk concentration of substance i, and the other symbols are as identified in the 1989 DHS report.[33] The data confirmed the hypothesized effects of bulk concentration and air flow rates on worker exposures, namely that the exposure to a particular substance is directly proportional to the bulk concentration and inversely proportional to the air flow rate.[34] Exposures are highest when bulk concentrations are high and air flow is low.

The exposure levels that would be expected to occur if alternative primers and cements were used, but all other working conditions were unchanged, can be estimated from:

$$c_{i,est} = c_{i,obs} \cdot \frac{B_{i,est}}{B_{i,obs}}$$

where $c_{i,est}$ is the estimated exposure to i under the modified conditions, $c_{i,obs}$ is the observed exposure, $B_{i,obs}$ is the bulk concentration in the conditions observed, and $B_{i,est}$ is the bulk concentration for the modified working conditions.[35] Full-shift exposure to multiple substances that can cause additive effects is reflected in the combined exposure index:

$$\%FSEL_{est} = \sum_i \left(\frac{c_{i,obs}}{FSEL_i} \cdot \frac{B_{i,est}}{B_{i,obs}} \right) \cdot 100\%$$

where $\%FSEL_{est}$ is the estimated combined exposure index under the modified conditions and $FSEL_i$ is the full-shift exposure limit for i.

Estimates of the combined exposure index were produced for the hypothetical scenario that a typical low-VOC primer and cement were used at all the CPVC potable water sites monitored for the 1989 DHS study.[36] The

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[33] Bellows, et al., 1989; p. 11.

[34] Bellows, et al., 1989; p.21 for short-term exposures, p. 23 for full-shift exposures.

[35] This incorporates a simplification from the original model that is valid only if the model parameter b_B is equal to unity, as hypothesized. The study data were entirely consistent with the hypothesis and support the simplified form of this estimate.

[36] The bulk concentrations used to produce these estimates were based on the manufacturers MSDSs for a leading brand (Oatey), as follows – primer: 12% THF, 72% MEK, 13% CHX, and 3% ACE; cement: 45% THF, 2.5% MEK, 7.5% CHX, and 30% ACE. As in the original study, the bulk concentration entered into the model was the average of the primer concentration and the cement concentration.

estimated combined exposures were *higher* than the observed exposures for all six CPVC-pw sites, by 11% to 155%. The highest estimated combined exposure ($\%FSEL_{est}$) was 229%, more than double the highest observed value for *%FSEL*. The average $\%FSEL_{est}$ for all sites would be 67.7%, nearly double the average observed *%FSEL* of 36%.[37]

These estimates, derived from study data collected under conditions of actual use and applied to the exposure model presented in the 1989 DHS study, directly contradict the assertions in the DEIR. The estimates indicate that widespread use of typical low-VOC primers and cements would actually *increase* the expected combined exposures.

This result is worth considering in some detail because it may at first seem counterintuitive. Consider as an example the site at which the combined full-shift exposure was 107%, the highest observed. One component of that exposure was 23 ppm MEK. The average bulk composition of the primer and cement used at the site was just 3.5% MEK (primer, 7%; cement, 0%). However, the average bulk composition of a typical low-VOC primer and cement is 37% (primer, 72%; cement, 2.5%), more than ten-fold higher.

Ten-fold higher bulk concentrations would be expected to result in ten-fold higher airborne concentrations as the primer and cement evaporate. The estimated MEK exposure for this example would be 243 ppm, exceeding the full-shift exposure limit of 200 ppm. Similar adjustments for the other constituents produce an estimated combined exposure of 189%.

e. The DEIR draws invalid inferences from the absence of documented, serious health effects in previous worker safety studies.

The DEIR notes correctly that previous systematic studies have not "found significant adverse effects on workers" installing CPVC pipe.[38] The DEIR then implies that this provides evidence for the safety of CPVC pipe installation. The inference is spelled out most clearly in the following passage: "The Lead Agency is not aware of any other data which demonstrates that the use of CPVC pipe has resulted in a pattern of workplace injury, despite the fact that there is a long history of it use in this State, other states, and other nations. The absence of this

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[37] Similar exposure estimates could be produced for short-term exposures, but are not presented.

[38] DEIR, p. 47.

information in the face of over a generation of use suggests a reasonable assurance that there is not a significant risk associated with CPVC."[39]

This inference is completely invalid and is unsupported by any analysis. Previous studies have not found much evidence of adverse health effects precisely because the studies were not intended or designed to examine adverse health effects. The 1989 DHS study, for example, included a survey in which participating workers were asked whether or not they had experience symptoms of ill health on the day(s) their exposures were monitored. The results of this symptom survey were not highlighted in the study's conclusions, because the study was explicitly "not designed for analysis of differences in self-reported symptoms among various exposure groups."

No rigorous comparison was possible between the self-reported symptoms of workers installing CPVC pipe and the symptoms of workers installing copper pipe. The study design, the data collection methods, and the statistical power were all inadequate to support any strong statement about health effects, so none was made. Any further interpretation in the DEIR is contrary to fundamental principles of epidemiology and biostatistics.

The 1989 DHS report did make the following observation: "The most commonly reported symptoms are noteworthy in that they are consistent with the known (or suspected) acute effects of overexposure to THF, MEK, CHX, and ACE: irritation of mucous membranes and skin, and depression of central nervous system function."[40] While the study was not designed to be able to formally test the hypothesis that exposure to plastic pipe primers and cements caused the reported symptoms, the data were certainly consistent with such a hypothesis.

Perhaps the Lead Agency did not realize that symptoms consistent with the health effects of toxic exposure were documented during the 1989 DHS study. Alternatively, perhaps the Lead Agency did not consider mucous membrane irritation and central nervous system depression to be "significant" adverse effects. However, as DHS has previously advised, "the consequence of repeated irritation... should not be lightly dismissed."[41] Further, central nervous system depression would certainly be significant for workers who drove vehicles

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[39] DEIR, p. 112-113.

[40] Bellows, et al., 1989: p. 16.

[41] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 3.

immediately after their work shifts, and that included virtually every worker in the study.

The 1989 DHS study made absolutely no attempt to identify signs or symptoms of other health effects the Lead Agency might consider more significant, such as liver or kidney damage. Ascertaining internal organ toxicity would have required a completely different study protocol. Thus the 1989 study offers absolutely no evidence – positive or negative – regarding liver or kidney damage associated with plastic pipe installation.

Only two other previous studies – the NIOSH Health Hazard Evaluations – offer any possibility of establishing a causal relationship between plastic pipe exposure and adverse health effects. The DEIR contains brief summaries of these studies,[42] but cites no data and offers no substantive analysis of how the study results did or did not contribute to the DEIR's findings.

A substantive analysis would have addressed the issue of whether or not the studies had adequate statistical power to find a relationship between exposures and outcomes if such a relationship truly existed. Consideration of the statistical power of a study is standard practice and is essential in properly interpreting study results. In fact, the NIOSH studies were like the 1989 DHS study in that they lacked the statistical power to support strong causal inferences about possible health effects of installing plastic pipe. Had the DEIR included any substantive analysis of these studies, it could only have concluded that they offer little support for statements such as "other data ... suggest a reasonable assurance that there is not a significant risk associated with CPVC."

Systematic studies of health effects related to toxic exposure are expensive and time-consuming. They are typically conducted only if indirect evidence suggests that an exposure has the potential to cause adverse health effects. Most often that evidence falls into two categories: case reports associating exposure with illness, or evidence of high exposures to substances found to cause adverse health effects in animal tests. Both kinds of evidence now exist indicating the potential for plastic pipe primers and cements to cause adverse health effects. This evidence indicates that systematic health effects studies could be appropriate at this time. In the absence of such studies, the health effects inferences in the DEIR are invalid and misleading.

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[42] DEIR, p. 66.

f. The DEIR misrepresents recent comments by the Department of Health Services.

Rather than providing an independent analysis of the impact of expanded CPVC use on worker health and safety, the DEIR draws heavily on recent DHS comments and on comments provided by an industry source.[43,44] Neither of these comments describe any substantive, scientific analysis of the frequency or severity of health effects that would result from the exposures expected during CPVC installation.

The DEIR summarizes the DHS comments as follows: "After review of all the information available, the DHS found that while THF may be found to be a human carcinogen in the future, it is not considered one at this time, and there is no reason to revise the conclusions of the 1989 study."

This summary is misleading. It suggests that the DHS opinion about the conclusions of the 1989 study was based on "all the information available." In fact, this statement was drawn from DHS' first comment letter, written when the Lead Agency had apparently provided DHS with incomplete and misleading information.

Specifically, the Lead Agency had chosen not to provide DHS with the National Toxicology Program (NTP) final draft report documenting evidence of THF carcinogenicity in mice and rats, the conclusions of which had already been approved by NTP's expert panel. The Lead Agency had also chosen not to forward to DHS case reports associating THF with liver and kidney toxicity and with seizures following exposure. These documents indicate that at least one conclusion from the 1989 DHS study needs to be updated. Conclusion #4 from the DHS report states in part: "for some of these substances (notably THF) the health effects of long-term exposure have not been studied."

Had the NTP bioassay report – documenting the health effects of long-term exposure – been in its possession at the time of its first comments, DHS would have been unable to responsibly assert that there is no reason to revise the 1989 conclusions. The Lead Agency apparently had also informed DHS that one-step cements are commonly used in California, while in fact such cements are not even approved for use. After these errors and omissions were brought to its attention, DHS' follow-up comments were more cautious and did not repeat

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[43] Comments of E. Katz, April 28, 1998 and June 11, 1998.

[44] Report of Robert G. Tardiff, 1997.

the opinion that there is no reason to revise the conclusions of the 1989 DHS report.

The DEIR states that the above-referenced information was "not otherwise available to the Lead Agency."[45] If true, this suggests that the Lead Agency's data gathering efforts were less than thorough, because the information is readily available and is central to any meaningful analysis of the potential impacts of expanded CPVC use.

g. The DEIR misrepresents the level of protection afforded by existing exposure limits.

The DEIR acknowledges that solvent overexposures occur during CPVC pipe installation, but discounts the possibility that these overexposures produce adverse health effects. Specifically, the DEIR asserts that "the workplace standards are set to protect the health of workers over their lifetimes with a substantial margin of safety for significant adverse health effects."[46] This assertion is integral to the DEIR's finding of no significant adverse impact on workers: "The Lead Agency does not consider the potential for solvent exposures to occasionally exceed standards based on lifetime exposure regimes, with a built-in margin of safety, to be a significant impact within the context of CEQA."[47]

The Lead Agency, however, fails to consider that the exposure limits for THF have not yet been updated to reflect the evidence of carcinogenic activity found in the NTP bioassay. NTP in its own report and based on its own findings commented, "exposure at the current occupational standard may pose a risk to human health."[48] In other words, the exposure limits for THF are out of date may provide no protection against significant adverse health effects.

The DEIR is also incorrect in implying that exposure limits in general provide a substantial margin of safety. Extensive research has shown that Threshold Limit Values (TLVs) in general do not provide any margin of safety and are in many instances not even protective of human health.[49] They are

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[45] DEIR, p. 67.

[46] DEIR, p. 47.

[47] DEIR, p. 47.

[48] National Toxicology Program, *Technical Report on the Toxicology and Carcinogenesis of Tetrahydrofuran in F344/N Rats and B6C3F$_1$ Mice*, Board Draft.

[49] Roach, S. Comments submitted to the Lead Agency in preparation 1989 DEIR.

instead most closely related to the economically-feasible exposure levels at the time the TLVs were established. The existing OSHA exposure standards for THF, MEK, CHX, and ACE were all drawn directly from early TLVs, so they cannot be considered to have any "substantial margin of safety."

The DEIR is also incorrect in stating that the referenced exposure limits are "based on lifetime exposure regimes," and implying that "occasional" overexposures are thus unlikely to produce significant health effects. For the solvents used in CPVC primers and cements, the full-shift and short-term exposure limits were established on the basis of health effects that can occur after a few hours or days of exposure. Exposures exceeding these limits thus have the potential to result in adverse health effects, even of the overexposures occur only occasionally.

Some of the solvent exposure limits were established on the basis of the solvents' ability to irritate eyes and mucous membranes. DHS has stated clearly: "Short-term irritation is a material impairment to health,"[50] and "The consequence of repeated irritation of eyes, nose, and throat should not be lightly dismissed. A growing body of evidence suggest that repeated irritation may contribute to chronic illness."[51]

Exposure limits are intended to be just that – limits on exposure. The potential for adverse health effects must also be taken into account any time exposure limits are exceeded, or when exposures are below existing limits but the limits are known not to reflect current toxicity information. In discounting the significance of regular exposures above existing exposure limits, the DEIR ignores the purpose of the exposure limits and is contrary accepted industrial hygiene practice.

h. The DEIR misrepresents the relevance of case reports of THF toxicity.

The DEIR implies that case reports of adverse health effects associated with THF exposure are not relevant, because they were associated with "massive overexposures."[52] Exposure levels were documented in only one of the case reports; short-term exposures in that case were 389–757 ppm and were

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[50] Bellows, et al., 1989: p. 73, from toxicology review by Frank Mycroft, PhD.

[51] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment.; p. 3.

[52] DEIR, p. 67.

indeed described as "massive."[53] The description may be appropriate, but the high exposure levels in no way make the case report irrelevant to the evaluation of potentially significant adverse health effects from CPVC installation. The highest short-term exposures measured in the 1989 DHS study fall in the same range. Similar exposures would indeed be expected, because the task (CPVC installation), work environment, and work practices were apparently all similar to those observed in the DHS study. Biological monitoring in the 1989 DHS study indicated that some workers' combined exposures (inhalation plus dermal) were in the same range even when averaged over an entire work day. The reported health effects following THF exposure are therefore entirely relevant to the DEIR.

High exposures are typical of case reports in occupational health. Individual cases or case series are typically documented and published precisely because they involve exposures noteworthy in their magnitude or novelty. The presence or absence of adverse health effects at lower exposure levels can be determined only by systematic epidemiologic study. High-exposure case reports typically serve as a first indication that adverse health effects are occurring in some exposed population, and often trigger systematic studies to determine the incidence and severity of adverse effects. Rather than dismissing the case reports of adverse effects associated with THF exposure, the Lead Agency should consider them an indication that systematic epidemiologic study may be warranted in preparation of the EIR.

i. The DEIR misrepresents the applicability and relevance of the NTP bioassay for THF.

The DEIR implies that the positive cancer bioassay for THF is not relevant, because tumors were found in test animals only at very high exposure levels.[54] This implication is misleading at two levels. First, the bioassay was conducted according to completely standard bioassay procedures.[55] Its results are therefore highly relevant to assessing the health risks of THF, just as are the results of any other standard cancer bioassay.

Perhaps more importantly, the exposure levels that produced tumors in male rats and female mice are not much greater than documented worker exposures. Excess tumors in male rats were produced by exposure to 600 ppm

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[53] Albrecht, WN, Boiano, JM, and Smith, RD, 1987. IgA glomerulonephritis in a plumber working with solvent-based pipe cement. *Industrial Health*; 25:157-158.

[54] DEIR, p. 67.

[55] National Toxicology Program, *Technical Report on the Toxicology and Carcinogenesis of Tetrahydrofuran in F344/N Rats and B6C3F$_1$ Mice*, Board Draft.

THF, lower than the highest estimated equivalent exposure level of 740 ppm documented in the 1989 DHS study for combined (inhalation plus dermal) exposure. Excess tumors were produced at and above 200 ppm in female mice, although the excess was not statistically significant for exposures for exposures below 1800 ppm. These data indicate that there is essentially no margin of safety between the THF exposures that cause cancer and laboratory animals and those that are experienced by workers installing CPVC pipe. The bioassay is therefore of critical importance in assessing the risks of THF exposure during CPVC installation and must be considered fully in evaluating the impact of expanded CPVC use.

j. Conclusions regarding the DEIR's finding of no significant adverse impacts to workers

The DEIR's finding of no significant adverse impact to workers is based upon unsupported assertions, misrepresentations, and misleading interpretations. Just as DHS commented on the earlier 1989 DEIR: "The DEIR's conclusion that repeated exposure would 'probably not accumulate to serious, long-term health risks' is entirely inappropriate."[56] In 1990 the Lead Agency addressed these concerns in the Administrative Final EIR by acknowledging the risks associated with CPVC pipe installation and by proposing substantive hazard reduction measures. The omission from the current DEIR of any clear acknowledgement of risk and any substantive exposure reduction proposals is cause for serious concern. Indeed, recent indications that THF has carcinogenic activity increase significantly the apparent risks associated with CPVC installation.

3. Expanded use of CPVC pipe would result in potentially significant impacts to workers.

Any meaningful assessment of potential impacts from expanded CPVC pipe use must be based on comparing worker exposures to the relevant exposure limits, to the exposure levels that have been associated with human toxicity, and to the levels that have produced adverse affects in laboratory animals. The worker exposures appropriately used in such an evaluation are those that can be expected to occur, based on the best available exposure data.

The best available exposure data for this purpose are those in the 1989 DHS study. This is hardly surprising since the 1989 study was expressly

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[56] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 2.

designed to produce data relevant to assessing the impact of expanded CPVC use.

The analysis in this section is based on the expectation that future exposures would be essentially the same as exposures measured in the 1989 DHS study. This is the most realistic and scientifically justified expectation. Despite the assertions in the DEIR that technological changes since 1989 have reduced worker exposures, no data or scientific analysis support these assertions. As presented in section 2.c. of these comments, no documented changes in working practices or environmental conditions have occurred since 1989. Absent specific measures to reduce exposures, future reductions cannot be expected.

The DEIR does indicate that the Lead Agency will affect future working conditions in one way: by requiring use of low-VOC primers and cements. Use of these materials would be expected to actually increase – not decrease – overall worker exposures as presented in section 2.d. of these comments. The magnitude of such an increase – and the nature of any changes in exposures to individual chemical constituents – depends upon the composition of the materials that will be used when the Lead Agency's new regulations are in effect. This information cannot be known at this time. The analysis in section 2.d. represents the most realistic and scientifically justified expectation, but is still less certain than the actual exposure data collected in the 1989 DHS study. Changed exposure levels – reflecting use of low-VOC primers and cements –are therefore not reflected in this section, except in estimating worst-case exposure levels.

a. *Full-shift and short-term solvent exposures in excess of established exposure limits must be expected on a regular basis among workers installing CPVC pipe.*

Based on air monitoring data collected during the 1989 DHS study, full-shift airborne solvent exposures in excess of exposure limits can be expected among workers installing CPVC pipe for potable water.[57] Airborne THF exposures are expected to exceed the legal exposure limit of 200 ppm on 5.5% of work days.[58] Airborne MEK exposures are expected to exceed the legal exposure limit of 200 ppm on 2.2% of work days. Additive exposure to airborne THF, MEK, CHX, and ACE – as expressed in the combined exposure index %FSEL – can be expected to exceed the 100% exposure limit on 10% of work days. These exceedances,

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[57] Bellows, et al., 1989: p. 21-23.

[58] Bellows, et al., 1989: Table 13, p. 47.

based on the most relevant available data collected during actual working conditions, indicate that regular overexposures must be expected during CPVC pipe installation.

Data from the 1989 DHS study indicate that many workers can also be expected to have substantial skin contact with primers and cements, and that for workers with heavy skin contact, dermal exposures may equal or exceed their airborne exposures.[59] For example, the worker with the highest measured urine THF concentration (6700 μg/l) had combined exposure (airborne plus dermal) equivalent to airborne exposure of 740 ppm THF, nearly four times the legal exposure limit. His actual airborne exposure was 158 ppm, suggesting that his dermal exposure contributed an additional THF dose equivalent to airborne exposure of 582 ppm, more than three-fold greater than his airborne exposure. This exposure occurred during installation of CPVC pipe for potable water supply, as did all the exposures that produced the highest urine THF concentrations.

For workers with little or no skin contact, the 1989 DHS study found that the relationship between airborne THF exposure and urine THF concentrations was best expressed as:

$$THF_{urine} = 9.0 \cdot THF_{airborne} + 84$$

where THF_{urine} is the urine THF concentration in μg/l and $THF_{airborne}$ is the airborne THF exposure in ppm.[60] This relationship suggests that full-shift airborne exposure at the legal exposure limit of 200 ppm would be associated with a urine concentration of 1884 μg/l in the absence of dermal exposure. Urine THF concentrations exceeded this level on 3 (21%) of 14 worker-days monitored for CPVC potable water installation.[61] These high urine concentrations are attributable to heavy dermal exposure, and represent combined (airborne plus dermal) exposures greater than allowed at the airborne exposure limit.

Short-term exposures must also be expected to exceed accepted exposure limits on a regular basis, based on data from the 1989 DHS study. THF exposures during 15-min intervals during CPVC potable water installation were up to 529 ppm, more than twice the exposure limit of 250 ppm.[62] THF exposures

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[59] Bellows, et al., 1989: p. 23-24.

[60] Bellows, et al., 1989: Figure 10, p. 57.

[61] Bellows, et al., 1989: Table 17, p. 48.

[62] Bellows, et al., 1989: p. 23-24.

can be expected to exceed the short-term exposure limit on 17-20% of 15-min intervals when workers are cementing joints in enclosed spaces.[63] For workers installing CPVC potable water pipe under typical conditions, short-term exposures are estimated to exceed the exposure limit at least once on 66% of work days.[64] MEK exposures are estimated to exceed the exposure limit on 5% of typical work days, and combined solvent exposures – measured by the combined exposure index %STEL – are estimated to exceed the exposure limit on 68% of typical work days.

Exposure limits do not represent an absolute threshold – below which no health effects will occur and above which effects are certain. Some workers may experience adverse health effects below the exposure limits while other workers may tolerate excursions above the limits. The exposure limits for CPVC solvents are not based on extensive dose-response data. For THF in particular, "exposure at the current occupational standard may pose a risk to human health."[65] These limitations notwithstanding, exposure limits provide a useful reference point. Exposure above the established exposure limits represents a risk of adverse health effects. The DEIR itself recognizes exposure limits as a key reference point, basing one of its three significance thresholds on "exceeding established workplace standards."[66]

b. Exposures higher than those measured in the 1989 DHS study must be expected under worst-case conditions.

The 1989 DHS study measured exposures under a wide range of working conditions, and investigated the relationship between exposure levels and various determining factors such as temperature, worksite air flow, bulk composition of primers and cements, presence of primer or cement spills, and the number of joints cemented in an exposure interval. During the course of the study, exposures exceeding established limits were documented, and were found to occur in association with several of these factors.[67]

However, no situations were observed or monitored in which all the factors that contribute to high exposures were present together. None of the monitoring

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[63] Bellows, et al., 1989: Table 8, p. 45.

[64] Bellows, et al., 1989: p. 20.

[65] National Toxicology Program, *Technical Report on the Toxicology and Carcinogenesis of Tetrahydrofuran in F344/N Rats and B6C3F$_1$ Mice*, Board Draft.

[66] DEIR, p. 42.

[67] Bellows, et al., 1989: Table 7, p. 44.

sites selected happened to have high temperatures, low air flow, extreme bulk composition, spills, and a high work pace, so exposure levels under these conditions were not measured. If widespread use of CPVC potable water pipe is approved, it must be expected that some installations will occur when all these factors are present together.

The 1989 DHS study was expressly designed to provide information that could support informed estimates of worst-case exposures. Most importantly, the impact on exposure levels of various working conditions was studied in some detail. Full-shift THF exposures were found to be significantly related to air flow rate, composition of bulk primers and cements, and ambient temperature, and MEK exposures were significantly related to air flow rate, composition of bulk products, and the number of joints cemented.[68] The DHS report warns against extrapolating beyond the conditions monitored, but can be validly used to estimate exposures that would occur if the most extreme conditions monitored were all to occur together.

For example, the highest measured full-shift exposure (107% of the full-shift exposure limit for combined exposure) was experienced by a worker installing CPVC potable water pipe. He was cementing a fairly large number of joints (35), in an enclosed space (air flow of 25 ft/min), at a moderate temperature (72° F), while other workers were also cementing joints in the same space.

Exposure levels under realistic worst-case conditions can be estimated as follows: The analysis in section 2.e. of these comments indicates that if a typical low-VOC primer and cement had been in use during the highest full-shift exposure period monitored, the expected index of combined exposure would have been 189%. If in addition the air flow rate had been 21 ft/min (the lowest observed during CPVC potable water pipe installation), the expected combined exposure index would have risen from 189% to 231% because of the reduced ventilation.[69] Similarly, if the number of joints cemented had been 90 (the highest

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[68] Bellows, et al., 1989: p. 22-23.

[69] This estimate is based on the regression coefficients shown in Bellows, et al., 1989: Table 14, p. 47. The coefficients are derived from a log-log model, so the appropriate calculation is:

$$c_{i,est} = \exp\left[\ln(c_{i,low-VOC}) + b_{v,i}(\ln v_{est} - \ln v_{obs})\right]$$

where $c_{i,est}$ is the estimated concentration of substance i under the hypothetical air flow conditions v_{est}, $c_{i,low-VOC}$ is the expected concentration of i under the observed air flow conditions v_{obs} and assuming use of low-VOC products, and $b_{v,i}$ is the regression coefficient for air flow rate. Exposures to CHX and ACE were estimated to remain unchanged in the reduced air flow conditions because the relationship between air flow and these substances was not presented in the 1989 DHS report. In fact, a similar relationship holds for these substances as for THF

observed during CPVC potable water pipe installation), the expected combined exposure would have risen further to 312%.[70] Finally, if the ambient temperature had been 102° F (the highest observed during the study), then the expected combined exposure would have been 602% (718 ppm THF, 460 ppm MEK, 2 ppm CHX, 15 ppm ACE).[71] This highest expected exposure value for THF must be interpreted with some caution, because the precise relationship between temperature and exposure levels has not been strongly established and because possible interaction between temperature and air flow has not been taken into account. (This caution does not apply to the values for MEK, CHX, and ACE, which were not adjusted for temperature.) The presence of other factors – such as additional spills or additional co-workers in the same enclosed area – could raise the exposures yet further, but the effects of such factors were not tested statistically in the 1989 DHS report and are thus not considered quantitatively here.

The same approach can be applied to estimating worst-case short-term exposure levels. The highest measured short-term exposure in the 1989 DHS study (an interval of the highest full-shift exposure analyzed above) had a combined exposure index of 181% (426 ppm THF, 33 ppm MEK, 4 ppm CHX, and 208 ppm ACE). Taking into account use of low-VOC products and reduced air flow as described above, expected combined exposures under realistic worst-case conditions would be 399% of the combined exposure limit (372 ppm THF, 642 ppm MEK, 7 ppm CHX, and 88 ppm ACE).[72] Basing a realistic worst-case estimate on a different short-term exposure interval at the same work site, expected combined exposures under realistic worst-case conditions would be 170% of the combined exposure limit (444 ppm THF, 12 ppm MEK, 13 ppm CHX, and 0.4 ppm ACE).

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and MEK. Had estimated CHX and ACE exposures been adjusted for reduced air flow, the estimated index of combined exposure would have been 233% instead of 231%.

[70] Calculation is completely analogous to that presented in the preceding footnote, adding adjustment for number of joints to the previous adjustments for bulk concentration and air flow. The relationship between exposure level and number of joints cemented was statistically significant only for MEK, so no adjustment was made for THF, CHX, or ACE exposures.

[71] The calculation is again completely analogous and the regression coefficient drawn from Table 14. The relationship between exposure level and temperature was not statistically significant for MEK, CHX, or ACE, so no adjustment was made for these substances.

[72] Calculations are analogous. Regression coefficients are from Bellows, et al., 1989: Table 9, p. 46. No adjustments were made for number of joints cemented because these data were not available. No adjustment was made for temperature because the THF regression coefficient reported in Table 9 is not plausible and would not be statistically significant under a one-tailed test.

The expected worst-case exposure values presented above are based upon several assumptions that have not been thoroughly tested, and the values thus have uncertainty associated with them. However, they are derived directly from the model and data presented in the 1989 DHS report, and are the best available scientifically-based estimates of exposure levels under realistic worst-case conditions. The estimates are conservative in the sense that they do not incorporate factors that are likely to increase exposures but that were not evaluated in detail during the 1989 DHS study. They demonstrate that exposures substantially greater than those documented in the 1989 DHS study can be expected to occur if widespread use of CPVC pipe is approved. In the case of full-shift exposures, estimated worst-case levels are more than five-fold greater than the highest measured levels. The expected worst-case exposures clearly far exceed established exposure limits, and must be considered significant in analyzing the impact of the project.

c. *THF exposures comparable to those previously associated with human health effects can be expected.*

Available data on the human health effects of THF are "extremely limited."[73] No systematic studies of THF health effects have been conducted. Only a few case reports have been published, and only one of these includes exposure data. In that case, glomerulonephritis was reported in a worker whose short-term exposures were 389-757 ppm THF.[74] A case report of hepatotoxicity involved workers whose exposures were qualitatively similar, but no exposure levels were reported.[75] These case reports do not definitively establish a causal relationship between exposure and subsequent illness, but in the absence of other studies they do suggest the potential for health effects to occur and provide a preliminary indication of the exposure levels that may produce adverse health effects. The State's own health experts recently concluded, "These case reports point to the likelihood that overexposure related to poor ventilation has already led to illness in pipe workers."[76]

The highest short-term THF exposure documented in the 1989 study (529 ppm) falls squarely in the 389-757 ppm range. An estimate of worst-case short-

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[73] Bellows, et al., 1989: p. 68, from toxicology review by Frank Mycroft, PhD.

[74] Albrecht, WN, Boiano, JM, and Smith, RD, 1987. IgA glomerulonephritis in a plumber working with solvent-based pipe cement. *Industrial Health*; 25:157-158.

[75] Garnier, R, Rosenberg, JM, et al., 1989. Tetrahydrofuran poisoning after occupational exposure. *British Journal of Industrial Medicine*. 46:677-78.

[76] Comments of Elizabeth Katz, MPH, Acting Chief, Hazard Identification System and Information Service, Department of Health Services; June 11, 1998.

term exposure (444 ppm) with low-VOC products also falls in the 389-757 ppm range. Full-shift airborne exposures up to 357 ppm THF can be expected under realistic worst-case conditions. Such exposures must be considered more likely to produce adverse health effects than would similar short-term exposures, because continued exposure at high levels would result in a higher internal dose. When dermal exposure is also taken into account, urine monitoring data from the 1989 DHS study suggest that combined (airborne plus dermal) exposures of workers with heavy skin contact was up to 740 ppm, also within the 389-757 ppm range. In short, many distinct analyses all indicate that exposures in the range previously associated with human health effects must be expected during installation of CPVC potable water pipe.

d. MEK exposures comparable to those previously associated with human health effects can be expected.

Several studies have reported human health effects in the range of 100-600 ppm MEK.[77] These effects include headache, nausea, and irritation of eyes, nose, and throat. As DHS noted in its response to the 1989 DEIR, "The consequences of repeated irritation of eyes, nose, and throat should not be lightly dismissed. A growing body of evidence suggests that repeated irritation may contribute to chronic illness."[78]

The highest short-term exposures documented in the 1989 DHS study (93 ppm for CPVC fire sprinkler installation and 53 ppm for CPVC potable water installation) approached but did not reach this range. However, expected short-term MEK exposures under realistic worst-case conditions (642 ppm) exceed the 100-600 ppm range. Exposures are expected to be particularly high with use of low-VOC primers and cements, since these typically contain more MEK than do the products commonly used in 1989. Expected full-shift exposures under realistic worst-case conditions (460 ppm) also fall within the 100-600 ppm range. Again, full-shift exposures of this magnitude must be considered more likely to produce adverse health effects than would similar short-term exposures, because continued exposure at high levels would result in a higher internal dose. These analyses indicate that MEK exposures in the range previously associated with human health effects must be expected during installation of CPVC potable water pipe.

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[77] Bellows, et al., 1989: p. 69, from toxicology review by Frank Mycroft, PhD.

[78] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 3.

e. *THF exposures during CPVC pipe installation approach the levels associated with cancer in laboratory animals, so THF-related cancers in exposed workers would not be unexpected.*

The NTP bioassay for THF found excess tumors in male rats exposed to 600 and 1800 ppm, and excess tumors in female mice exposed to 1800 ppm. Female mice exposed to 200 to 600 ppm had somewhat increased tumors in comparison with unexposed controls, but the increase was not statistically significant. In summary, THF produced excess tumors at 600-1800 ppm in laboratory animals.[79]

The highest THF exposure measured in the 1989 DHS study (529 ppm) approached this range, but was not sustained over a full workshift. The highest full-shift exposure (158 ppm) was somewhat below the 600-1800 ppm range. Expected full-shift airborne exposure under realistic worst-case conditions (357 ppm) are closer but still somewhat below the 600-1800 ppm range. With dermal exposure taken into account, data from the 1989 DHS study suggest that combined (airborne plus dermal) exposures of workers with heavy skin contact was up to 740 ppm, within the 600-1800 ppm range. Cancers produced by THF exposure would not be unexpected, given that worker exposures during CPVC installation approach or exceed the levels that produce tumors in laboratory animals, leaving essentially no margin of safety.

A fuller assessment of the cancer risk associated with THF exposures is best provided by a toxicologist. Such an assessment would be based either on accepted safety factors or on a more sophisticated model, depending on a number of considerations. The exposure data presented in these comments could be used as inputs into a more detailed cancer risk assessment.

f. *Installation practices for CPVC pipe indicate that a higher frequency of accidental injuries can be expected, in comparison with copper pipe installation.*

These comments have focused largely on the potential for the solvents in CPVC primers and cements to produce illnesses – including cancers and liver or kidney damage – in exposed workers. Such illnesses may indeed be particularly severe, and are cause for significant concern. However, acute traumatic injuries that occur during pipe installation are more immediate and perhaps more common, and also merit attention.

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[79] National Toxicology Program, *Technical Report on the Toxicology and Carcinogenesis of Tetrahydrofuran in F344/N Rats and B6C3F$_1$ Mice*, Board Draft.

The 1989 DHS report noted, as one of its key conclusions, that "Pipe installation workers face a variety of safety hazards including: chain saws and wood-boring tools used in awkward positions, unsafe ladders, and objects falling from above."[80] In preparing the 1989 DEIR, the Lead Agency asserted without substantiation that "increased use of plastic pipe may also lead to a decrease of unknown magnitude in the risk of accidental injury."[81] DHS experts then advised the Lead Agency that such a conclusion could not be supported and that it ignored two key risk factors identified during the 1989 DHS study "that could well lead to an increase in serious accidents" during CPVC installation.[82] Specifically, DHS highlighted documentation in its 1989 report that workers installing CPVC potable water pipe were less experienced than other plumbers and that they worked at a faster pace. Both factors must be expected to increase the frequency of injury.

The 1989 DHS report also provides documentation of another risk factor that could result in a greater frequency of accidental injuries during CPVC installation. The four solvents used in CPVC primers and cements – THF, MEK, CHX, and ACE – all have the ability to profoundly depress central nervous system (CNS) function at sufficiently high doses. Subtle depression of CNS function at lower exposures has been studied only for acetone, which was found to cause mild CNS depression at 250 ppm.[83] Exposures to these solvents were highest during CPVC potable water pipe installation, and are expected to exceed exposure limits on a regular basis. Together with the toxicity information, these data suggest that CPVC pipe installation workers may experience some degree of solvent-induced CNS depression. Indeed, dizziness was the second most common symptom of ill health reported by workers participating in the 1989 DHS study. Dizziness was reported by 11% of workers completing a symptom survey; headache was reported by 10%.

Workers with depressed CNS function would be at higher risk of experiencing an accidental injury, either during pipe installation or while driving a motor vehicle after exposure. The principle mechanisms would be slowed reflexes, impaired judgement, and/or reduced sensory acuity. Any solvent-induced CNS depression would be exacerbated by alcohol consumption. Based on reported occurrence of subtle CNS depression at solvent exposure levels

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[80] Bellows, et al., 1989: p. 34.

[81] 1990 DEIR.

[82] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 3.

[83] Bellows, et al., 1989: p. 72, from toxicology review by Frank Mycroft, PhD.

comparable to those expected to occur during CPVC pipe installation, CPVC installation presents a risk of increased accidental injuries.

The Lead Agency in the current DEIR seems to have disregarded the earlier DHS advice that CPVC installation entails risk factors that would increase – not decrease – the frequency of accidental injuries, including fatalities. While the "Lead Agency... points out that many of the workplace hazards faced by pipe fitters are unrelated to the type of pipe used,"[84] it does not mention the risk factors associated with CPVC installation and it highlights a very few injuries related uniquely to copper installation.

Specifically, the DEIR refers to seven accidental injuries associated with copper pipe during 1980-1997, and implies that reducing copper pipe use would result in fewer severe accidental injuries.[85] The seven reported injuries may have been somewhat unique in that they could be attributed to the pipe material itself, but they constitute only a tiny fraction of all injuries associated with pipe installation. For comparison, during the same period approximately 600 work-related fatalities occurred among plumbers, pipefitters, and steamfitters. Most were caused by falls, motor vehicle injuries, or by exposure to harmful substances and environments. During the same period, approximately 540,000 disabling injuries (those with at least one lost work day) occurred among plumbing, heating and air conditioning employees.[86]

Most accidental injuries to plumbers arise from the overall installation process, not from contact with the pipe itself. Any risk factors that increased the frequency of accidental injuries during pipe installation could produce a significant burden of excess injuries, and those excess injuries could far outnumber the few injuries directly attributable to pipe material. Fast work pace, little training and experience, and exposure to CNS-depressing solvents are all risk factors that place CPVC pipe installation workers at increased risk of accidental injury. These factors suggest that widespread use of CPVC pipe in place of copper is likely to result in increased accidental injuries.

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[84] DEIR, p. 113.

[85] DEIR, p. 69-70.

[86] Fatality and injury figures derived from Bureau of Labor Statistics data for 1996, conservatively estimating that injury rates and total employment had been constant from 1980-1997.

g. Conclusions regarding significant adverse health effects.

Workers installing CPVC potable water pipe can be expected to experience solvent exposures in excess of established exposure limits. This conclusion is based upon the airborne exposures documented in the 1989 DHS study, the combined (airborne plus dermal) exposures indicated by biological monitoring in the 1989 DHS study, and the exposures that can be expected under realistic worst-case conditions. The solvent exposures that can be expected are in a range that has been previously associated with human health effects. The exposures and are also comparable to the levels that produced tumors in laboratory animals. As a result, human health effects must be expected, and cancers would not be unexpected.

An industry consultant cited repeatedly in the DEIR agrees that solvent exposures during CPVC installation have the potential to produce adverse health effects: "The amount of CPVC pipe cleaner and/or cement exposures necessary to result in an absorbed dose sufficient to elicit the less serious adverse health effects in humans... has not been quantified; however the range may be from 25 to 150 ppm. Therefore, installers... may be receiving doses in this range of concentrations sufficient to cause some of these effects."[87] (The consultant qualified this conclusion with a phrase – omitted here from the quoted passage – limiting the conclusion to "installers who are improperly installing CPVC pipe." As these comments have indicated previously, a meaningful analysis must be based on exposures that can be expected under conditions of normal use.)

The consultant also concluded: "The more serious health effects, including adverse hematologic, hepatic, renal, ocular, and neurological effects occur only at much higher levels of exposure, i.e., 300 to 6,000 ppm, to which installers would rarely, if ever, be exposed." The toxicology summary in this statement is perhaps somewhat conservative, but the conclusion regarding exposure levels is clearly inconsistent with the data and with evidence-based analysis. Biological monitoring in the 1989 DHS study indicated that at least two (14%)of 14 CPVC pipe installation workers had combined (airborne plus dermal) exposures greater than 300 ppm. This prevalence can in no way be considered "rare." Expected exposures under realistic worst-case conditions are also in the 300-6,000 ppm range. CPVC pipe installation workers can indeed be expected to experience solvent exposures at levels associated with "more serious health effects" in humans.

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[87] Comments of Robert Tardiff, PhD: p. 17.

4. The DEIR fails to consider cumulative impacts on worker health and safety.

The DEIR explicitly addresses cumulative impacts in other areas, but is conspicuously silent on cumulative impacts to worker health.[88] This oversight is significant.

a. The DEIR fails to consider as a cumulative impact the high exposures that occur when CPVC potable water pipe is installed concurrently with other plastic piping.

The 1989 DHS study clearly indicated that solvent exposures during CPVC potable water pipe installation were highest when plastic DWV pipe was being installed concurrently in the same work area.[89] The solvent vapors produced by cementing CPVC potable water pipe, released into the same work space as solvent vapors produced by cementing ABS or PVC drain, waste, and vent lines constitute a significant cumulative impact.

b. The DEIR fails to consider impacts of installing CPVC pipe in non-residential occupancies.

The Lead Agency states that "it is reasonable to assume" that the current DEIR could be used (by other agencies) to extend CPVC approval to structures other than residential buildings.[90] In the area of worker health and safety, the "environment" impacted during residential construction differs in key respects from the "environment" of commercial construction, so the data and analyses supporting the current DEIR cannot be validly applied to the commercial plumbing environment.

The 1989 DHS study states explicitly: "Conclusions about the possible hazards of installing residential plumbing do not directly apply to the hazards faced by these same workers at other sites."

The interviews and walk-through surveys conducted at the outset of the 1989 DHS study revealed many differences between residential and commercial installations. Most obviously and perhaps most importantly, non-residential installations generally involve larger pipe sizes and more piping. Larger pipe

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[88] DEIR, p. 97-102.

[89] Bellows, et al., 1989: p. 19.

[90] DEIR, p. 11.

sizes require larger cemented surfaces, and thus a greater volume of cement. Applying a greater volume of cement requires more care and more time, so the cement is spread thin for a longer period before each joint is completed. All these factors indicate a greater opportunity for primer and cement constituents to volatilize into workers' breathing zones.

Other factors also differ. Much of the plumbing is typically installed later in the construction process on non-residential buildings, so the structure is more enclosed and ventilation is reduced. Work crews are often larger on larger-scale construction, providing more opportunity for concurrent exposure. Both factors would produce higher exposure levels.

Extending the widespread use of CPVC to non-residential buildings would also increase workers' long-term cumulative solvent exposures, along with increasing their risk of cancer or other chronic toxicity. Complete assessment of adverse health impacts associated with CPVC installation in non-residential buildings would need to consider both types of cumulative impacts: concurrent exposures within work groups, and increased long-term cumulative exposures for workers employed in both residential and commercial installations.

c. *The DEIR fails to consider the potential health impacts of cumulative long term exposures, among plumbers who install both CPVC potable water pipe and other plastic piping systems.*

A third type of cumulative impact must also be considered. Much of the focus of the 1989 DHS study was on short-term exposures, largely because there existed at that time little information on chronic toxicity – such as cancer – at the observed exposure levels. Exposures within a work day were characterized in some detail, but no effort was made to evaluate plumbers' exposures over a period of months or years. Such issues are relatively unimportant in assessing risks of acute toxicity.

The 1996 results of the NTP cancer bioassay for THF have changed raised significant new issues. Most significantly, cancer risk assessment depends critically upon estimates of long-term cumulative exposures. Consider as a hypothetical example a residential plumber who currently installs copper potable water pipes during 50% of work time and PVC drain, waste, and vent lines during the other 50%. Suppose as a result of the proposed project this plumber's duties are changed, and are then split evenly between installing CPVC potable water pipes and PVC drain, waste, and vent lines. Even if the peak exposure levels are unchanged, and even if the average on any given work day is unchanged, the long-term cumulative exposure would be doubled. Cancer risk would also be doubled, using the most common cancer risk assessment models.

The DEIR cannot fully assess potential health impacts to workers without explicitly considering cumulative effects. Three kind of cumulative impacts must be considered: increased exposure levels resulting from concurrent installation of CPVC potable water pipe and ABS or PVC drain, waste, and vent lines, installation of CPVC pipe in non-residential buildings, and increased long-term cumulative solvent exposures even when these installations are not concurrent.

5. Mitigation measures should be established to address the potentially significant health hazards.

As outlined in the preceding section, CPVC pipe installation under typical conditions results in exposures that regularly exceed established exposure limits and that have been associated with adverse health effects in humans and laboratory animals. The appropriate industrial hygiene response would be to design and implement measures to control the exposures, reducing them to safer levels.

DHS advised the Lead Agency in response to the 1989 DEIR: "We believe that the exposures known to occur during installation of plastic plumbing pipe are significant enough that HCD must provide some mechanism for assuring, more directly, that the recommended control measures are adopted throughout the industry."[91] The Lead Agency accepted the earlier DHS recommendation, incorporating specific, substantive mitigation measures in the 1990 Administrative Final EIR. Indeed, the Lead Agency determined that such mitigation measures were "essential" to protect worker health.[92] The need for mitigation measures has increased since that time, primarily because of the findings of the NTP cancer bioassay for THF.

The current DEIR refers repeatedly to the notion that worker exposures would be lower – and acceptable – if workers would follow the safe use recommendations on material labels and MSDSs. The principal recommendations are to "avoid contact with skin" and to "use only with adequate ventilation." This vague language gives no concrete guidance to workers or their employers. Even a careful reading of the material labels would leave unanswered questions such as: How carefully must skin contact be avoided? Are gloves an appropriate barrier to skin contact? What kind of gloves? How much ventilation is "adequate"?" As noted in the 1989 DHS study: "Many workers

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[91] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 1.

[92] 1990 Administrative Final EIR, p. 79.

considered the label warnings – such as 'avoid contact with skin' and 'use only in well-ventilated areas' – to be comically impractical."[93]

Reliance on vague warning labels cannot be considered an appropriate or effective prevention strategy. Hazard control measures are successful largely to the extent that they are carefully designed, specific to the particular exposure conditions, readily implemented, and integrated into existing (or modified) work practices. Warning labels alone do not meet any of these standards.

Reducing exposures below the levels observed in 1989 will require specific, focused measures. A comprehensive intervention plan would be beyond the scope of these comments, but some options are described in the following paragraphs. A comprehensive intervention could be designed by using any combination of options that would reliably and effectively reduce exposures to acceptable levels. No single option can be expected to reduce exposures sufficiently. Some of the options outlined would have overlapping effects; not all would be needed to control exposures.

Note that the options outlined are only *possible* control measures. They would need to be carefully adapted to specific working conditions, and their effectiveness must be evaluated before they can be considered effective and reliable. A fundamental aspect of any hazard control strategy is assignment of responsibility, but indicating the responsibilities of various parties is beyond the scope of these comments.

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[93] Bellows, et al., 1989: p. 14.

a. *Options for reducing airborne exposures:*

i. modify primer and cement formulations to reduce airborne emissions;

ii. develop and disseminate clear, specific guidance about the conditions under which mechanical ventilation is needed, including any tools needed to determine whether those conditions are present at a particular worksite;

iii. require mechanical ventilation whenever CPVC pipe is installed in an enclosed space, and provide a mechanism for assuring that this requirement is heeded;

iv. to prevent cumulative exposures, prohibit concurrent installation of CPVC potable water pipe and any other plastic piping system, and provide a mechanism (such as separate inspections of each piping system) to assure that installations are not concurrent;

v. require that all workers evacuate any enclosed space in which a substantial volume of primer or cement has been spilled, and that work not resume until vapors from the spill have dissipated (simply wiping a spill is likely to be counterproductive – increasing its surface area and thus increasing the rate at which vapors are released);

vi. develop a mechanism to assure that plumbing contractors bidding on CPVC pipe installation jobs are knowledgeable in methods for limiting airborne solvent exposures and that they provide all needed equipment; or

vii. develop a mechanism to assure that CPVC pipe installation workers receive regular, comprehensive, effective training in methods for limiting airborne solvent exposures.

b. *Options for reducing dermal exposures:*

i. modify primer and cement formulations to reduce dermal absorption;

ii. develop and deploy a device that could apply primer and cement to pipe and fittings within an enclosed chamber (as an illustration, imagine a device similar to an electric pencil sharpener – a pipe end would be inserted rough and withdrawn with primer and cement applied, ready to be inserted immediately into a fitting);

iii. require use of chemical protective gloves during all handling of CPVC primers and cements (providing gloves can be identified that give reliable, lasting protection against liquid THF, MEK, CHX, and ACE);

iv. add brightly colored dye to all primers and cements to discourage unnecessary skin contact;

v. develop a mechanism to assure that plumbing contractors bidding on CPVC pipe installation jobs are knowledgeable in - methods for limiting dermal solvent exposures and that they provide all needed equipment; or

vi. develop a mechanism to assure that CPVC pipe installation workers receive regular, comprehensive, effective training in methods for limiting dermal solvent exposures.

Unless a comprehensive package of reliable, effective exposure control measures are adopted, solvent exposures in the future will be similar to those observed by DHS in 1989. Those exposures can be expected to produce adverse health effects in CPVC pipe installation workers.

6. Conclusions

The DEIR's significance thresholds for worker health and safety are fundamentally flawed, and do not provide meaningful criteria for the existence of significant impacts. As a result, the DEIR's conclusion that CPVC pipe installation will not result in significant adverse impacts to workers is also fundamentally flawed.

The DEIR's finding of no significant impacts on worker safety is not supported by data or scientific analysis, and is based on several misrepresentations, incorrect assertions, and invalid inferences. A key assertion is that use of low-VOC primers and cements would reduce exposures. This assertion is not supported by facts or analysis; an evidence-based analysis indicates that combined exposures to THF, MEK, CHX, and ACE would actually be increased. In many instances, the Lead Agency has disregarded the advice of its own health experts, provided in 1990 during preparation of the earlier EIR.

Expanded use of CPVC pipe would result in potentially significant health impacts to workers. Full-shift and short-term overexposures would occur on a regular basis. Skin contact with primers and cements would result in dermal absorption, and in some cases dermal absorption could outweigh airborne exposures. Expected exposure levels under realistic worst-case conditions would be at least twice as high as the highest exposures measured in the 1989 DHS study. Exposures would be similar in magnitude to the exposure levels previously associated with THF and MEK toxicity in humans, and similar in magnitude to the levels that produced excess tumors in laboratory animals. These exposures must be considered a significant impact.

The DEIR fails to consider cumulative impacts on worker health and safety, even though the 1989 DHS report clearly indicated that exposures were highest when CPVC potable water pipe was installed concurrently with other types of plastic piping systems. The DEIR also fails to consider impacts of installing CPVC pipe in non-residential occupancies, if the approval of CPVC pipe for potable water supply was to be extended to commercial installations. The DEIR also fails to consider the impacts of cumulative long-term exposures among workers who would install CPVC potable water piping on some work days and other plastic pipe on other days. These failures are particularly significant in light of recent evidence of carcinogenicity for THF, which increases the importance of cumulative lifetime exposures. Significant cumulative impacts can be expected.

Reliance on vaguely-worded material labels cannot be considered an effective strategy to reduce exposures. A combination of reliable, effective mitigation measures should be established to reduce exposures to acceptable

levels. In the absence of such measures, significant adverse health effects among workers can be expected.

DHS reached a similar conclusion in 1990: "We believe that the exposures known to occur during installation of plastic plumbing pipe are significant enough that HCD must provide some mechanism for assuring, more directly, that the recommended control measures are adopted throughout the industry."[94] This conclusion is just as applicable now as it was eight years ago. The most significant development since 1990 is the new evidence that THF has carcinogenic activity. This strengthens considerably the importance of assuring that workers are not exposed in the future at the levels documented in 1989.

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[94] Comments of Richard Jackson, MD, then Chief of the Office of Environmental Health Hazard Assessment. December, 1989; p. 1.

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Curriculum Vitae

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Certification

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Industrial Hygienist
California Department of Health Services, Occupational Health Program
(under contract with the Health Officers Association of California), 1987–1989.

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ilename : Saf4Cmnt

Method Standard : ASTM F739-96 (Mod.)

Material Log No. : 98075-09-01

Test Date : 7/29/98

Analyst

QC Date 8/11/98

PERMEATION TEST REPORT

Material Name : Safety 4H Glove

Conditioning : None

Chemical : Oatey Lo-V.O.C. CPVC Cement+

Source : Orchard Supply Hardware

Test Temperature : 27 deg. C

Test Duration : 8 Hours

Concentration : 100 %

CAS No. : N/A

TEST RESULTS	*CELL 1*		*CELL 2*		*CELL 3*		*Average*	*Std. Dev.*
Actual Breakthrough : *(time in minutes)*	6		12		99		39	42
Normalized Breakthrough : *(time in minutes)*	9		72		384		155	164
Maximum Rate Detected: *(ug/cm2*min)*	2.4		0.66		0.17		1.1	0.96
Unit Area Weight (g/cm2)	0.0074		0.0079		0.0074		0.0076	0.0002
Sample thickness (.001")	3		3		3		3	0.0

Modifications of Method : 1" Cells

Analytical Technique : PID 10.2 Lamp

Sampling Frequency : Every 3 minutes

Chemical physical state : Liquid

Type of chemical contact : Continuous

Collection medium : Dehumidified Air

Minimum detection limit : .11 ppm

Minimum detectable rate : 0.011 ug/cm2*min

\+ Notes: Mixture of chemicals was analyzed using Response Factor for THF aquired 8/7/98

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated box tests with excessive breakthrough may reflect maximum rates that are artificially low.

TRI / Environmental, Inc.
9063 Bee Caves Road
Austin, TX 78733
Phone : (512) 263-2101

Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

. ilename : Saf4prim

Method Standard : ASTM F739-96 (Mod.)

Material Log No. : 98075-09-01

Test Date : 7/29/98

Analyst / QC Date 8/11/98

PERMEATION TEST REPORT

Material Name: Safety 4H Glove

Conditioning : None

Chemical : Oatey Lo-V.O.C. CPVC Primer+

Source : Orchard Supply Hardware

Test Temperature : 27 deg. C

Test Duration : 8 Hours

Concentration : 100 %

CAS No. : N/A

TEST RESULTS	CELL 1		CELL 2		CELL 3		Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480		>480		>480		N/A	N/A
Normalized Breakthrough : (time in minutes)	>480		>480		>480		N/A	N/A
Maximum Rate Detected: (ug/cm2*min)	<.006		<.006		<.006		N/A	N/A
Unit Area Weight (g/cm2)	0.0074		0.0079		0.0074		0.0076	0.0002
Sample thickness (.001")	3		3		3		3	0.0

Modifications of Method : 1" Cells

Analytical Technique : PID 10.2 Lamp

Sampling Frequency : Every 3 minutes

Chemical physical state : Liquid

Type of chemical contact : Continuous

Collection medium : Dehumidified Air

Minimum detection limit : 0.04 ppm

Minimum detectable rate : 0.004 ug/cm2*min

\+ Notes: Mixture of chemicals was analyzed using Response Factor for THF aquired 8/7/98

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated box tests with excessive breakthrough may reflect maximum rates that are artificially low.

COMPOUNDS PRESENT IN FINAL SAMPLE OF OATEY LO-V.O.C. CPVC CEMENT TEST

August 7, 1998

COMPOUND	Total μg			$\mu g/cm^2*min.$		
	Cell 1	Cell 2	Cell 3	Cell 1	Cell 2	Cell 3
Tetrahydrofuran	47μg	11μg	<7.5μg	0.62μg	0.14μg	<0.1μg
All Other Compounds	<7.5μg	<7.5μg	<7.5μg	<0.1μg	<0.1μg	<0.1μg

COMPARISON OF COMPOUNDS OF OATEY LO-V.O.C. CPVC CEMENT AND PRIMER TO PS WELD-ON PVC CEMENT AND PRIMER

August 7, 1998

PS Weld-On PVC 2711 Series 2000 Plastic Pipe Cement		**Oatey LO-V.O.C. CPVC Cement**	
Chemical Component	**Percentage**	**Chemical Component**	**Percentage**
Acetone	<5%	Acetone	20%
Methyl Ethyl Ketone	30%	Methyl Ethyl Ketone	<5%
Tetrahydrofuran	45%	Tetrahydrofuran	60%
Cyclohexanone	25%	Cyclohexanone	10%
PS Weld-On PVC/CPVC P-70 Plastic Pipe Primer		**Oatey LO-V.O.C. Purple Primer**	
Acetone	<5%	Acetone	<5%
Methyl Ethyl Ketone	40%	Methyl Ethyl Ketone	75%
Tetrahydrofuran	50%	Tetrahydrofuran	5%
Cyclohexanone	10%	Cyclohexanone	20%

Based on Gas Chromatography sensitivity rate of <7.5 $\mu g/cm^2$*min. for Tetrahydrofuran and <0.1 $\mu g/cm^2$*min. for all other compounds. Percentages are based on ±2.5%.

RESEARCH REPORT

INCOMPATIBLE BUILDING MATERIALS

HOUSING
TECHNOLOGY
SERIES

CMHC SCHL

HOME TO CANADIANS
Canada

CMHC—Home to Canadians

Canada Mortgage and Housing Corporation (CMHC) is the Government of Canada's national housing agency. We help Canadians gain access to a wide choice of quality, affordable homes.

Our mortgage loan insurance program has helped many Canadians realize their dream of owning a home. We provide financial assistance to help Canadians most in need to gain access to safe, affordable housing. Through our research, we encourage innovation in housing design and technology, community planning, housing choice and finance. We also work in partnership with industry and other Team Canada members to sell Canadian products and expertise in foreign markets, thereby creating jobs for Canadians here at home.

We offer a wide variety of information products to consumers and the housing industry to help them make informed purchasing and business decisions. With Canada's most comprehensive selection of information about housing and homes, we are Canada's largest publisher of housing information.

In everything that we do, we are helping to improve the quality of life for Canadians in communities across this country. We are helping Canadians live in safe, secure homes. CMHC is home to Canadians.

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To reach us online, visit our home page at www.cmhc.ca

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Incompatible Building Materials

A report documenting premature failure in residential construction resulting from material incompatibility

Canada Mortgage and Housing Corporation

June 2003

Prepared by:
J.F. Burrows Consulting

For:
Policy and Research Division,
Canada Mortgage and Housing Corporation

CMHC offers a wide range of housing-related information, For details, call 1 800 668-2642
or visit our Web site at www.cmhc.ca

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Produced by CMHC

Note to users

This report documents and shares information about building material incompatibilities.

It opens with a "Quick Reference Guide to Incompatibilities." The Quick Reference Guide is a fast and easy way to find out if a material is incompatible with other materials.

Appendix B, page 48, is the survey form that was CMHC used to solicit incompatibility reports for this document. We encourage you to share your experience with additional incompatible building materials by completing the survey and returning it to CMHC.

The text of this document is also available on-line, at the CMHC Web site, at www.cmhc.ca.

Table of Contents

Quick reference guide to incompatibilities **1**

Executive Summary **5**

Introduction **7**

Purpose 7
Criteria for inclusion 7
Research intent and accuracy 7
Causes of material incompatibility 8
Methodology 9
Advisory committee 9
Research 9
Survey 10
Screening 10
Verification 10
Report 10
Communication plan 11
Trend analysis 11

Examples of Incompatibility **13**

Division 1–General Requirements **13**
Division 2–Sitework **13**
Division 3–Concrete **14**
General information 14
3.1.1 Concrete/Steel (ferrous metal) 14
3.1.2 Concrete/non ferous metals 14
Division 4–Masonry **15**
Division 5–Metals **16**
General information 16
Types of protection 18
Other metal-related reports 19
5.1.1 Copper tubing/Aggressive soils 19
5.1.2 Copper pipe/Plumbing 20
5.1.3 Copper flashing/Metal fasteners 20
5.1.4 Metal strapping seismic restraint/Hot water heaters 21
Division 6–Wood and Plastics **22**
Other wood - related reports 22
6.1.1 Metal Fasteners/Cedar, redwood and treated wood products in exposed locations 22
Division 7–Thermal moisture protection **23**
General information 23
7.1 Envelope 23
7.1.1 Housewrap/Surfactants 23
7.1.2 Exterior membranes/Sunlight 23
7.1.3 Peel-and-stick membranes/Vinyl windows 24

7.1.4 Vinyl siding/Rigid insulation 24
7.2 Roofing....24
7.2.1 Bituminous membranes/Polyisocyanurate foam insulation 24
7.2.2 Bitumens/Polystyrene foam insulation 26
7.2.3 EPDM membranes/Bituminous-based air barrier membranes and flashings 26
7.2.4 Roofing membranes/Heat-applied roofing products 26
7.3 Sealants....26
General information 26
7.3.1 Sealants/Rigid insulation 28
7.3.2 Sealants/Vent pipes 29
7.3.3 Silicone sealants, acid-cure/Other materials 30
7.3.4 Silicone sealant/Mirrors 30
7.3.5 Silicone sealants/General....30
7.3.6 Plumbers putty/Sunlight....31
7.3.7 Polyurethane sealant/Polyethylene 31
7.3.8 Polyurethane sealant/Asphaltic materials....32
Division 8–Doors and windows 33
Division 9–Finishes 34
9.1 Coatings 34
General information 34
9.1.1 Paint/Wood knots....35
9.2 Flooring, resilient....36
General information: 36
9.2.1 Resilient flooring/Concrete sub-base....36
9.2.2 Resilient flooring/Wood panel sub-floor 36
9.2.3 Resilient flooring/Floor fills and toppings....37
9.2.4 Resilient flooring/Latex-backed rugs and mats....37
Division 10–Specialties....38
Division 11–Equipment 38
Division 12–Furnishings 38
Division 13–Special construction....38
Division 14–Conveying systems 38
Division 15–Mechanical....39
15.1 High-temperature vent pipes/Combustion gas....39
Division 16–Electrical 40
16.1.1 Smoke alarms/Halogen lighting....40
16.1.2 Electrical wiring/CPVC pipe 40

Trend Analysis 41
Education 41
Sealants....41
Builder awareness....41
Uses of materials....42

Instruction labels 43
Trend summary 43

Building Code Issues 44

Appendix A: Research Sources 45

Industry associations 45
Architectural associations 45
Government and regulatory bodies 46
Research and university 46
Publications 46
Periodicals 47

Appendix B: Survey 48

Acknowledgements 49

Advisory committee 49
Technical reviewers 49
Survey respondents 49

Division 16–Electrical

16.1.1 Smoke alarms/Halogen lighting

Problem: There are reports that some types of hard-wired, multi-station smoke alarms commonly used in residential construction are prone to false alarms when they are wired in series with receptacles or fixtures that include halogen lighting. The false alarm problem can occur with multi-station smoke alarms that are low-voltage interconnect units–when one smoke detector in a circuit goes into alarm, it sends a low-voltage signal (9VDC) to put the other alarms on the circuit into alarm. The false alarms are caused by voltage fluctuations resulting from the transformers powering the halogen lights.

Nuisance false alarms can result in homeowners temporarily disconnecting the smoke alarm, or in some cases, removing the alarm, leaving no alarm protection in the case of fire.

Reporting source: Construction management firm

Solution: The best solution is to ensure smoke alarms do not share a circuit with other devices. Otherwise, check with the manufacturer to ensure smoke alarms are compatible with proposed wiring arrangements. This problem was reported for one particular type of smoke alarm. The solution reported is the use of another model (by the same manufacturer) that operates by maintaining a line voltage and is therefore less prone to voltage fluctuations in the circuit.

16.1.2 Electrical wiring/CPVC pipe

Problem: Certain types of wire and cable jacketing may contain "plasticizers" that are used to make the plastic insulation softer and more flexible. When wiring with jackets that contain these plasticizers are in constant contact with plastic components such as chlorinated polyvinyl chloride (CPVC) pipe, the plasticizers may leach out and cause the pipe to soften. Occasional contact during building construction (for example, dragging wires across CPVC pipe) does not seem to transfer enough plasticizer to cause a problem.

Reporting source: B.C. architect

Solution: Wiring should be kept isolated from CPVC pipe and other plastic materials.

Trend Analysis

The first effort at compiling examples of material incompatibility has generated 35 examples (in addition, there are many other examples that have not been included because they were seen to be inappropriate uses of materials or violation of well-known good practices). The analysis of the examples that were included in this report (and others that were not included) results in some general observations about particular areas of difficulty.

Education

Several examples were reported that involve dissimilar metals. While there will always be examples of incompatibility that cannot be avoided–even the manufacturer has not foreseen certain limitations–many incompatibilities are well documented but are either ignored or not recognized. Therefore, it is likely that recurring metal incompatibilities demonstrate a need for ongoing training or skills upgrading.

Sealants

Sealants are a group of materials with a fairly high number of reported incompatibilities. This is likely due to the wide range of formulations and applications for such products. Because they are often formulated for specific applications, problems or poor performance are bound to occur when a sealant is used for an application for which it was not designed.The General Information section for sealants will assist builder practitioners to make educated sealant selections. It would be helpful for all stakeholders if sealant tubes had a simple label used by all manufacturers that indicated product uses and limitations.

Builder awareness

Builder surveys provide insight into where the majority of building defects are occurring.

A 1992 survey made by the NAHB Research Centre determined that the most frequent reports of callbacks were attributable to:

- Paints/caulks/finishes
- Flooring
- Windows and skylights
- Doors
- Foundations and basements
- Siding and trim
- Structural sheathing
- Wallboard
- Foundation insulation and waterproofing
- Framing

A survey of the major housing defects reported to the Ontario Home Warranty Program in 1994 by homeowners listed, in order of frequency, the following:

- Gypsum wallboard
- Foundation wall
- Window/door/skylight
- Trim and moldings
- Windows/skylights/skylight frames

Although there is no direct link between defects and incompatibilities, this information indicates assemblies that require special vigilance, and a reminder to ensure known building material incompatibilities are avoided as a possible source of failure in assemblies with a high history of defects.

From time to time, new materials or building techniques enter the marketplace with the promise of performance and cost-effectiveness. In some cases, unforeseen service conditions or circumstances result in major difficulties. Exterior insulated finish systems (EIFS), composite sidings and polybutelyne water piping are examples of materials or systems that did not perform as expected, and indicate that product testing and building code development do not circumvent all possible problems. Therefore, the designer and builder need to continually be educating themselves and making careful choices based on experience and judgment.

Builders are renowned for job-site ingenuity and innovation. Using tools and materials in unforeseen ways to ease effort may result in economies but may also result in unsafe work conditions or practices that violate building science principles or code requirements. Care is required when applying innovation, but as a minimum, job-site time savers should respect known material incompatibilities.

Uses of materials

In some cases, incompatibility results from using materials outside their range of approved or tested applications. For example, it was reported that contractor's sheathing tape, designed for sealing vapour/air barriers, is used for applications for which it may perform but performance has not been tested or approved.

The Canadian Construction Materials Centre (CCMC) is one of the organizations that evaluates new materials, products, systems and services for all types of construction. The results of the product evaluations are published in the highly regarded CCMC Registry of product evaluations. Published quarterly on the CCMC Web site (www.nrc.ca/ccmc/) and annually in print, the Registry contains evaluation reports that include complete, illustrated descriptions of products, instructions for use along with any restrictions and detailed test results. Each report also contains an impartial technical opinion of how a product performs in relation to its planned use.

In the case of sheathing tape, the CCMC evaluations assess the performance of the tape with specific sheathing and membrane materials. If the tape is used with other sheathing material or for other applications, there is no guarantee of performance and in some cases, usage may be contrary

to code requirements. For example, there are reports of both sheathing tape and duct tape being used to seal duct joints in forced-air heating systems without clear indication that the tapes meet the NBCC flame-spread requirements for such applications.

Although duct tape has many useful temporary uses on the job site, its effectiveness for permanent applications is doubtful, and it is reported to have a very short performance effectiveness in applications close to heat sources. It is essential to ensure that innovative uses of products do not violate building code requirements.

Instruction labels

From the cases uncovered during the research for this project, it is obvious that some problems encountered by builders result from a failure to read or respect product limitations noted on the product packaging. For example, the rush to apply paint in unheated conditions as fall temperatures decrease often ignores the temperature application ranges recommended on the product.

While exceeding the product limits may get the project completed in time, it also brings a fairly high likelihood of recalls later, often at higher cost than doing the work according to instructions in the first place.

Trend summary

Building is a complex process that requires knowledge of a wide array of products and principles. Education and continual skills upgrading is needed for building professionals to stay aware of the limitations of both old and new products. It appears that many incompatibilities could be avoided if:

1. Manufacturers could find a clearer, harmonized way to indicate product limitations on product packaging. Sealants, for example, have numerous formulations and there are many manufacturers. A standard label on each tube of sealant indicating best uses, appropriate and inappropriate uses would help simplify product selection.
2. Building professionals need to read and understand product uses and limitations and make product selections that will avoid incompatibility problems.

Building Code Issues

There were two reports that pertained to the building code and product standard. These have been passed to the appropriate agency for possible action.

Appendix A: Research Sources

This list summarizes the groups, publications, associations, companies and organizations contacted by telephone, e-mail or Web site review during the research stage of gathering cases of building material incompatibilities.

Industry associations

Alberta Floor Covering Association

Alliance of Canadian Building Officials

Building Envelope Research Consortium

Building Owners and Managers Association

Canadian Association of Home and Property Inspectors

Canadian Home Builders' Association

Canada Mortgage and Housing Association

Canadian Roofing Contractors Association

Canadian Wood Council

Construction Specifications Institute

Energy & Environmental Building Association

Forintek Canada Corp.

Greater Vancouver Home Builders Association

Homeowner Protection Office of British Columbia

Manufactured Housing Institute

National Association of Home Builders

National Association of Home Builders Research, ToolBase Hotline

Partnership for Advancing Technology in Housing (PATH)

Starline Windows

Architectural associations

Alberta Association of Architects

Architects' Association of New Brunswick

Architectural Institute of British Columbia

Manitoba Association of Architects

Nova Scotia Association of Architects

Ontario Association of Architects

Ordre des architectes du Québec

Royal Architectural Institute of Canada

Saskatchewan Association of Architects

Government and regulatory bodies

Canadian General Standards Board

Housing and Urban Development (HUD)

Institute for Research in Construction,

Canadian Construction Materials Centre

Occupational Safety and Health Administration

Public Works and Government Services Canada, National Master Specifications

Research and university

Australian Material Safety

Commonwealth Scientific and Industrial Research Organisation, Australia

Concordia University, Department of Building, Civil, and Environmental Engineering

Institute Of Materials, U.K.

Oakridge National Laboratory, Energy Sciences

Pennsylvania Housing Research Center

University of Illinois, Seitz Materials Research Laboratory

University of Maryland Materials Research Science and Engineering Center

University of Ottawa, Environmental Health and Safety Service

University of Pennsylvania, Materials Research Society

University of New Brunswick, Civil Engineering, Materials

University of New Orleans, Advanced Material Research Institute

University of Southern Mississippi, School Of Engineering Technology

University of Waterloo, Civil Engineering

University of Windsor

Publications

ASM Handbook Volume 11: *Failure Analysis and Prevention*, R.J. Shipley, W.T. Becker, ASM International.

Building Materials: *Dangerous Properties of Products in Masterformat Divisions 7 and 9*, H. Leslie Simmons, Richard J. Lewis, Sr., Wiley.

Construction Sealants and Adhesives, 3rd Edition, Julien R. Panek, John Phillip Cook, Wiley.

Durability by Design, National Association of Home Builders Research Centre, 2002.

Failure Mechanisms in Building Construction, David H. Nicastro, American Society of Civil Engineers (ASCE Press), 1997.

Wall Moisture Problems In Alberta Dwellings, Technical Series 2000-112, CMHC

Periodicals

AIA Architecture

Architectural Digest

Architectural Record

Architectural Journal

Architectural Record

Builder Magazine (NAHB)

Builder Online

Canadian Building Digest

Canadian Home Builder Magazine

Canadian House and Cottages

Fine Homebuilding

Hanley-Wood Publications

Homes and Cottages

Journal of Light Construction

McGraw Hill Construction (ENR, Sweets, Arch Record, etc)

Progressive Architecture

Professional Builder Professional Remodeler NAHB

This Old House

ToolBase E news

Appendix B: Survey

INCOMPATIBLE BUILDING MATERIALS

In 2003, Canada Mortgage and Housing Corporation completed a report titled "Incompatible Building Materials" to document cases of building material incompatibility reported by builders, renovators, inspectors and architects. The report is intended to initiate shared learning so that others can avoid problems.

The report is a start to the identification of building materials incompatibility. You can help by adding your knowledge and experience to future editions of the report by completing and returning the survey form below.

Typical documented examples of incompatibilities

Framing materials

Fasteners affected by cedar, redwood and treated wood products in wet locations

Wet materials: sealants, adhesives and coatings

Solvent-based sealants, adhesives and damp-proofing affecting polystyrene rigid insulation

Silicone sealant affecting paintability and recaulking

General

Metals affecting metals–dissimilar metals

Copper tubing affected by aggressive (acidic soils)

Your example

Your name: _____ **Tel:** ( ) _____ **Email:** _____

Problem (symptoms, causes, conditions, time-frame etc.): _____

_____

_____

_____

Solution (if there is one): _____

_____

_____

Return to:

CMHC
Policy and Research Division
700 Montreal Road, Ottawa, ON
K1A 0P7

email: dsmith@cmhc.ca
tel: (613) 748-2348
fax: (613) 748-2402

Att: Darrel R. Smith
Senior Researcher

Acknowledgements

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Walter Burningham, W.E. Burningham & Associates

Don Johnston, Canadian Home Builders Association

Alphonse Caouette, Canadian Construction Materials Centre (CCMC):

Paul Morris and Jennifer O'Conner, Forintek Canada Corp.

Bob Switzer, Polygon Construction Management Ltd.

Skip Lennox, Glidden ICI Paints

John Straube, University of Waterloo

Chad Foreshew, Ontario New Home Warranty

Rick Bortolussi, City of Richmond/B.C. Building Officials Association:

Technical reviewers

Lyndon Mitchell, NRC, "Division 3–Concrete"

Sivan Parameswaran, NRC (retired), "Division 5–Metals"

Paul Morris, Forintek Canada Corp., "6.1.1"

Bruno Di Lenardo, Canadian Construction Materials Centre, IRC, "7.1 Envelope"

Joseph Borsellino, Patenaude JBK, "7.2 Roofing"

Jerome Klosowski, sealants expert, "7.3 Sealants"

Skip Lennox, Glidden ICI Paints, "9.1 Coatings"

Jean Claude Carisse, National Floor Covering Association, "9.2 Flooring, Resilient"

Alberta Floor Covering Association, "9.2 Flooring, Resilient"

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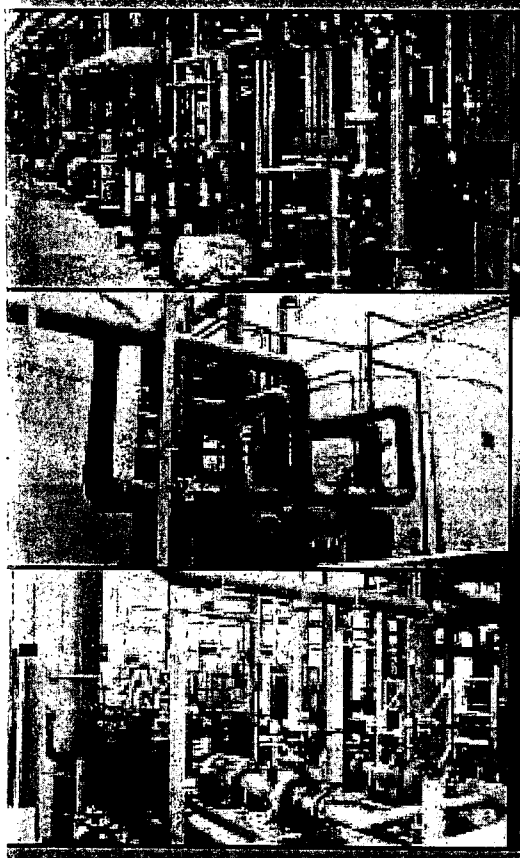
INDUSTRIAL SYSTEMS

Chemical Resistance Data



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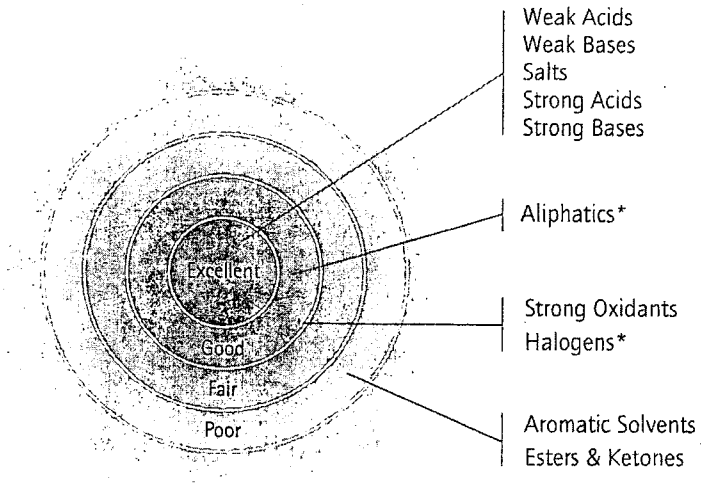


Corzan® CPVC
Chemical Resistance

*Consult Noveon for specific data.

One of the key advantages of Corzan® CPVC is its excellent resistance to a broad range of corrosive environments. By replacing traditional materials with Corzan® CPVC, engineers can extend equipment service life and reduce maintenance, while minimizing process life-cycle costs. This technical report is intended to provide engineers and end-users with guidance as to the suitability of Corzan® industrial piping systems in corrosive applications. In general, Corzan® CPVC is inert to most mineral acids, bases, salts, and aliphatic hydrocarbons, and compares favorably to other non-metals in these chemical environments. Specific use conditions must also be considered since these will determine the chemical resistance of any thermoplastic piping system. Variables that can affect chemical resistance include chemical concentration, temperature, pressure, external stress, and final product quality. Since the number of possible use conditions is so large, the final decision regarding material suitability often must be based on in-service testing. The information contained in this report was developed to include conditions that are most often encountered in industry. CPVC samples were immersed in the particular reagent for at least 90 days at 73°F (23°C) and 180°F (82°C). Changes in weight and tensile strength for each sample were reviewed in conjunction with field experience and information gathered from various sources to develop recommendations shown. Note that these recommendations are based on specific use conditions and may not apply to all situations. For this reason, the final decision regarding material suitability must rest with the end-user. The notes following the chemical resistance chart list specific areas where caution must be used when considering Corzan® CPVC. Additional chemical resistance data will become available as testing of Corzan® CPVC continues. Consult with your product supplier or Noveon for the latest Corzan® CPVC chemical resistance information.

N.B. Information presented within this report is based on test data and field experience of CPVC manufactured by Noveon and is not intended to reflect the properties found with other suppliers of CPVC materials. To determine if your supplier is using Corzan CPVC, call the Corzan Marketing Department at 888-234-2436.

Corzan™ is a trademark of Noveon, Inc. and is registered or under application in various countries of the world.

Chemical Compatibility Case Study

An excellent example of an industrial system's performance in a demanding process application is an installation at Kodak's state-of-the-art lithographic plate manufacturing facility in Colorado. At this facility Kodak manufactures more than 8,000 varieties of lithographic offset printing plates in dimensions up to ten feet long.

To manufacture the plates, large coils of aluminum are unrolled, and one side of the aluminum sheet is chemically treated to provide a grained surface, which is then coated with a light-sensitive photopolymer. After this coating step, the aluminum is cut to the appropriate dimensions and packaged.

The Kodak Story

Prior to the construction of the plate manufacturing facility in 1990, Jim Loomis, Senior Plate Manufacturing Engineer, was faced with many important design decisions. Not only would the piping material have to meet Kodak's high quality standards, but it would have to safely handle the aggressive chemicals used in the plate etching process at temperatures up to 180°F (82°C).

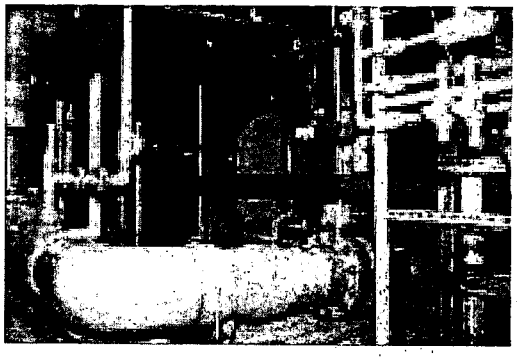
Some of the chemicals used in the process are:

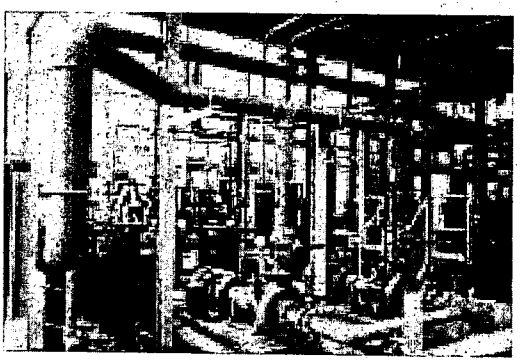
- Caustic Etching Solution
- 30% Nitric Acid
- 50% Sodium Hydroxide

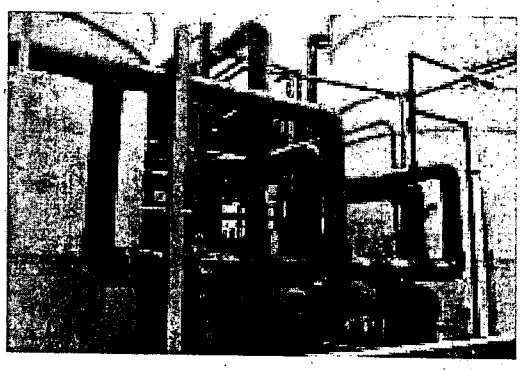
In addition, Jim wanted to specify the system in a single material for design efficiency and quality assurance. The system also had to be available in iron pipe sizes from 1" (25mm) up to 12" (300mm), including a wide variety of piping, fittings and valves.

After a comprehensive materials study, one material, CPVC, was specified for the entire system. Resistance to a variety of harsh chemicals at high temperatures, as well as mechanical strength up to 180°F (82°C) were all key elements in specification decision. Jim was also extremely pleased with the economically-priced process piping and components available from a team of quality manufacturers.

If your next project includes corrosive chemicals, high temperatures, or a wide range of service conditions, think of Corzan Industrial Systems first.







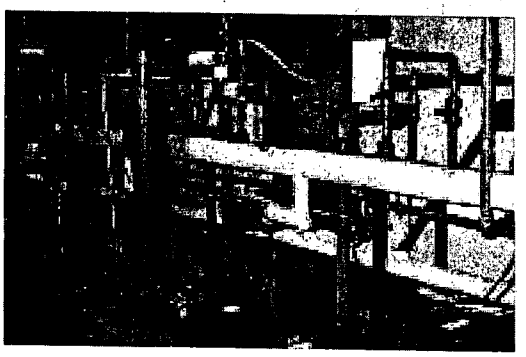


TABLE I – Chemical Resistance of Corzan® CPVC

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Acetaldehyde	N	N
Acetic Acid, up to 10%	R	180
Acetic Acid, greater than 10%	C	C
Acetic Acid, Glacial	N	N
Acetic Anhydride	N	N
Acetone, up to 5%	R	180
Acetone, greater than 5%	C	C
Acetone, pure	N	N
Acetyl Nitrile	N	N
Acrylic Acid	N	N
Acrylonitrile	N	N
Adipic Acid, sat'd in water	R	200
Alcohols	C	C
Allyl Alcohol	C	C
Allyl Chloride	N	N
Alum, all varieties	R	200
Aluminum Acetate	R	200
Aluminum Chloride	R	200
Aluminum Fluoride	R	200
Aluminum Hydroxide	R	200
Aluminum Nitrate	R	200
Aluminum Sulfate	R	200
Amines	N	N
Ammonia	N	N
Ammonium Acetate	R	200
Ammonium Benzoate	R	200
Ammonium Bifluoride	R	200
Ammonium Carbonate	R	200
Ammonium Chloride	R	200
Ammonium Citrate	R	200
Ammonium Dichromate	R	200
Ammonium Fluoride	R	200
Ammonium Hydroxide, 28%	N	N
Ammonium Hydroxide, 10%	N	N
Ammonium Hydroxide, 3%	C	N
Ammonium Nitrate	R	200
Ammonium Persulfate	R	–
Ammonium Phosphate	R	C
Ammonium Sulfamate	R	200
Ammonium Sulfate	R	200
Ammonium Sulfide	R	200
Ammonium Thiocyanate	R	200
Ammonium Tartrate	R	200
Amyl Acetate	N	N
Amyl Alcohol	C	C
Amyl Chloride	N	N
Aniline	N	N
Antimony Trichloride	R	200
Aqua Regia	R	N
Aromatic Hydrocarbons	N	N
Arsenic Acid	R	–
Barium Carbonate	R	200
Barium Chloride	R	200
Barium Hydroxide	R	200
Barium Nitrate	R	200
Barium Sulfate	R	200
Barium Sulfide	R	200
Beer	R	200
Beet Sugar Liquors	R	200
Benzaldehyde	N	N

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Benzene	N	N
Benzoic Acid, sat'd in water	R	N
Benzyl Alcohol	N	N
Benzyl Chloride	N	N
Bismuth Carbonate	R	200
Black liquor	R	200
Bleach, household (5% Cl)	R	200
Bleach, industrial (15% Cl)	R	200
Borax	R	200
Boric Acid	R	200
Brine Acid	R	200
Bromine	N	N
Bromine, aqueous, sat'd	R	200
Bromobenzene	N	N
Bromotoluene	N	N
Butanol	C	C
Butyl Acetate	N	N
Butyl Carbitol	N	N
Butyl Cellosolve	N	N
Butyric Acid, up to 1%	R	180
Butyric Acid, greater than 1%	C	C
Butyric Acid, pure	N	N
Cadmium Acetate	R	200
Cadmium Chloride	R	200
Cadmium Sulfate	R	200
Calcium Acetate	R	200
Calcium Bisulfide	R	200
Calcium Bisulfite	R	200
Calcium Carbonate	R	200
Calcium Chlorate	R	200
Calcium Chloride	R	200
Calcium Hydroxide	R	200
Calcium Hypochlorite	R	200
Calcium Nitrate	R	200
Calcium Oxide	R	200
Calcium Sulfate	R	200
Cane Sugar Liquors	R	200
Caprolactam	N	N
Caprolactone	N	N
Carbitol	N	N
Carbon Dioxide	R	200
Carbon Disulfide	N	N
Carbon Monoxide	R	200
Carbon Tetrachloride	N	N
Carbonic Acid	R	200
Castor Oil	C	C
Caustic Potash	R	180
Caustic Soda	R	180
Cellosolve, all types	N	N
Chloric Acid	R	180
Chlorinated Solvents	N	N
Chlorinated water, (hypochlorite)	R	200
Chlorine, dry gas	N	N
Chlorine, liquid	N	N
Chlorine, trace in air	R	200
Chlorine, wet gas	N	N
Chlorine dioxide, aqueous, sat'd	R	200
Chlorine water, sat'd	R	200

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Chlorobenzene	N	N
Chloroform	N	N
Chromic Acid, 40% (conc.)	R	180
Chromium Nitrate	R	200
Citric Acid	R	200
Citrus Oils	N	N
Coconut Oil	N	N
Copper Acetate	R	200
Copper Carbonate	R	200
Copper Chloride	R	200
Copper Cyanide	R	200
Copper Fluoride	R	200
Copper Nitrate	R	200
Copper Sulfate	R	200
Corn Oil	N	N
Corn Syrup	R	200
Cottonseed Oil	N	N
Creosote	N	N
Cresol	N	N
Crotonaldehyde	N	N
Cumene	N	N
Cupric Fluoride	R	200
Cupric Sulfate	R	200
Cuprous Chloride	R	200
Cyclohexane	N	N
Cyclohexanol	N	N
Cyclohexanone	N	N
Detergents	C	C
Dextrin	R	200
Dextrose	R	200
Dibutyl Phthalate	N	N
Dibutyl Ethyl Phthalate	N	N
Dichlorobenzene	N	N
Dichloroethylene	N	N
Diethylamine	N	N
Diethyl Ether	N	N
Dill Oil	N	N
Dimethylformamide	N	N
Disodium Phosphate	R	200
Distilled Water	R	200
EDTA, Tetrasodium –	R	200
Esters	N	N
Ethanol, up to 5%	R	180
Ethanol, greater than 5%	C	C
Ethers	N	N
Ethyl Acetate	N	N
Ethyl Acrylate	N	N
Ethyl Benzene	N	N
Ethyl Chloride	N	N
Ethyl Ether	N	N
Ethylene Bromide	N	N
Ethylene Chloride	N	N
Ethylene Diamine	N	N
Ethylene Glycol, up to 50%	R	180
Ethylene Glycol, greater than 50%	C	C
Ethylene Oxide	N	N
Ferric Chloride	R	200
Ferric Hydroxide	R	200
Ferric Nitrate	R	200

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Ferric Sulfate	R	200
Ferrous Chloride	R	200
Ferrous Hydroxide	R	200
Ferrous Sulfate	R	200
Fluorine gas	N	N
Fluosilicic Acid, 30%	R	180
Formaldehyde	N	N
Formic Acid, up to 25%	R	180
Formic Acid, greater than 25%	C	N
Freons	C	C
Fructose	R	200
Gasoline	N	N
Glucose	R	200
Glycerine	R	200
Glycol Ethers	N	N
Green Liquor	R	200
Halocarbon Oils	N	N
Heptane	C	–
Hydrazine	N	N
Hydrochloric Acid	R	180
Hydrochloric Acid, 36% (conc.)	R	180
Hydrofluoric Acid, 3%	R	–
Hydrofluoric Acid, 48%	C	C
Hydrofluosilicic Acid, 30%	R	180
Hydrogen Peroxide, 50%	R	–
Hydrogen Sulfide, Aqueous	R	180
Hypochlorous Acid	R	180
Isopropanol	C	C
Ketones	N	N
Kraft Liquors	R	200
Lactic Acid, 25%	R	200
Lactic Acid, 85% (Full strength)	R	C
Lead Acetate	R	200
Lead Chloride	R	200
Lead Nitrate	R	200
Lead Sulfate	R	200
Lemon Oil	N	N
Limonene	N	N
Linseed Oil	N	N
Lithium Chloride	R	200
Lithium Sulfate	R	200
Lubricating Oil, ASTM 1, 2, 3	R	–
Magnesium Carbonate	R	200
Magnesium Chloride	R	200
Magnesium Citrate	R	200
Magnesium Fluoride	R	200
Magnesium Hydroxide	R	200
Magnesium Salts, inorganic	R	200
Magnesium Nitrate	R	200
Magnesium Oxide	R	200
Magnesium Sulfate	R	200
Maleic Acid, 50%	R	180
Manganese Sulfate	R	200
Mercuric Chloride	R	200
Mercuric Cyanide	R	200
Mercuric Sulfate	R	200
Mercurous Nitrate	R	200
Mercury	R	180
Methane Sulfonic Acid	R	180

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Methanol, up to 10%	R	180
Methanol, greater than 10%	C	C
Methanol, pure	N	N
Methyl Cellosolve	N	N
Methyl Chloride	N	N
Methyl Ethyl Ketone	N	N
Methyl Formate	N	N
Methyl Isobutyl Ketone	N	N
Methyl Methacrylate	N	N
Methylamine	N	N
Methylene Chloride	N	N
Mineral Oil	R	–
Monoethanolamine	N	N
Motor Oil	R	–
Muriatic Acid	R	180
Naphthalene	N	N
Nickel Acetate	R	200
Nickel Chloride	R	200
Nickel Nitrate	R	200
Nickel Sulfate	R	200
Nitric Acid, up to 25%	R	150
Nitric Acid, 25-35%	R	130
Nitric Acid, 70%	R	105
Nitrobenzene	N	N
1-Octanol	C	N
Oils, edible	N	N
Oils, Sour Crude	N	N
Oleum	N	N
Olive Oil	N	N
Oxalic Acid, Sat'd	R	170
Oxygen	R	180
Ozonized water	R	200
Palm Oil	N	N
Paraffin	R	180
Peanut Oil	N	N
Perchloric Acid, 10%	R	–
Phenylhydrazine	N	N
Phosphoric Acid	R	180
Phosphorus Trichloride	N	N
Picric Acid	N	N
Pine Oil	N	N
Plating Solutions	R	180
Polyethylene Glycol	N	N
Potash	R	200
Potassium Acetate	R	200
Potassium Bicarbonate	R	200
Potassium Bichromate	R	200
Potassium Bisulfate	R	200
Potassium Borate	R	200
Potassium Bromate	R	200
Potassium Bromide	R	200
Potassium Carbonate	R	200
Potassium Chlorate	R	200
Potassium Chloride	R	200
Potassium Chromate	R	200
Potassium Cyanate	R	200
Potassium Cyanide	R	200
Potassium Dichromate	R	200
Potassium Ferricyanide	R	200
Potassium Ferrocyanide	R	200

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Potassium Fluoride	R	200
Potassium Hydroxide	R	200
Potassium Hypochlorite	R	200
Potassium Iodide	R	200
Potassium Nitrate	R	200
Potassium Perborate	R	180
Potassium Perchlorate, sat'd	R	180
Potassium Permanganate, sat'd	R	180
Potassium Persulfate, sat'd	R	–
Potassium Phosphate	R	200
Potassium Sulfate	R	200
Potassium Sulfide	R	200
Potassium Sulfite	R	200
Potassium Tripolyphosphate	R	200
Propanol, up to 0.5%	R	180
Propanol, greater than 0.5%	C	C
Propionic Acid, up to 2%	R	180
Propionic Acid, greater than 2%	C	C
Propionic Acid, pure	N	N
Propylene Dichloride	N	N
Propylene Glycol, up to 25%	R	180
Propylene Glycol, greater than 25%	C	C
Propylene Oxide	N	N
Pyridine	N	N
Sea Water	R	200
Silicic Acid	R	–
Silicone Oil	R	–
Silver Chloride	R	200
Silver Cyanide	R	200
Silver Nitrate	R	200
Silver Sulfate	R	200
Soaps	R	200
Sodium Acetate	R	200
Sodium Aluminate	R	200
Sodium Arsenate	R	200
Sodium Benzoate	R	200
Sodium Bicarbonate	R	200
Sodium Bichromate	R	200
Sodium Bisulfate	R	200
Sodium Bisulfite	R	200
Sodium Borate	R	200
Sodium Bromide	R	200
Sodium Carbonate	R	200
Sodium Chlorate	R	200
Sodium Chloride	R	200
Sodium Chlorite	R	200
Sodium Chromate	R	200
Sodium Cyanide	R	200
Sodium Dichromate	R	200
Sodium Ferricyanide	R	200
Sodium Ferrocyanide	R	200
Sodium Fluoride	R	200
Sodium Formate	R	200
Sodium Hydroxide	R	180
Sodium Hypobromite	R	200
Sodium Hypochlorite	R	200
Sodium Iodide	R	200
Sodium Metaphosphate	R	200

Reagent	Temperature 73°F (23°C)	Max. Temp. (°F)
Sodium Nitrate	R	200
Sodium Nitrite	R	200
Sodium Perborate	R	180
Sodium Perchlorate	R	180
Sodium Phosphate	R	200
Sodium Silicate	R	200
Sodium Sulfate	R	200
Sodium Sulfide	R	200
Sodium Sulfite	R	200
Sodium Thiosulfate	R	200
Sodium Tripolyphosphate	R	200
Soybean Oil	N	N
Stannic Chloride	R	200
Stannous Chloride	R	200
Stannous Sulfate	R	200
Starch	R	200
Stearic Acid	R	–
Strontium Chloride	R	200
Styrene	N	N
Sugar	R	200
Sulfamic Acid	R	180
Sulfur	R	–
Sulfuric Acid, (see page 7)		
Sulfuric Acid, Fuming	N	N
Sulfuric Acid, 98%	R	125
Sulfuric Acid, 85%	R	170
Sulfuric Acid, 80%	R	180
Sulfuric Acid, 50%	R	180
Tall Oil	C	C
Tannic Acid, 30%	R	–
Tartaric Acid	R	–
Terpenes	N	N
Tetrahydrofuran	N	N
Tetrasodiumpyrophosphate	R	200
Texanol	N	N
Thionyl Chloride	N	N
Toluene	N	N
Tributyl Phosphate	N	N
Trichloroethylene	N	N
Trisodium Phosphate	R	200
Turpentine	N	N
Urea	R	180
Urine	R	200
Vegetable Oils	N	N
Vinegar	R	200
Vinyl Acetate	N	N
Water, Deionized	R	200
Water, Demineralized	R	200
Water, Distilled	R	200
Water, Salt	R	200
Water, Swimming Pool	R	200
WD-40	C	C
White Liquor	R	200
Xylene	N	N
Zinc Acetate	R	200
Zinc Carbonate	R	200
Zinc Chloride	R	200
Zinc Nitrate	R	200
Zinc Sulfate	R	200

R – Recommended N – Not recommended C – Caution, further testing suggested – suspect with certain stress levels – Incomplete data N.B. Given percentages are by weight

Noted Caution Areas for CPVC

CPVC is not recommended for use with most polar organic materials including various solvents i.e., chlorinated or aromatic hydrocarbons, esters, or ketones.

Resistance of CPVC to certain other fluid mixtures such as fuel oils with moderate aromatic content cannot be determined on basis of immersion testing alone. Actual use data must be obtained.

There are a number of similarities in chemical resistance between PVC and CPVC materials. However, one must exercise caution when comparing the chemical resistance properties of CPVC to those of PVC, which are not always the same.

CPVC test samples exposed while under stress to surfactants, certain oils, or grease have shown signs of environmental stress cracking. Environmental stress cracking is a situation in which the manufactured pipe or fittings are weakened by contact with certain chemicals and cracks are propagated by external stresses. External stresses include not only the known pressure stress on a system but also stresses from sources such as expansion and installation. When CPVC is intended for use in handling such chemicals, special consideration should be taken during design and installation to avoid unusual stresses in the piping system, or advance testing of the chemical in simulated use conditions is strongly suggested.

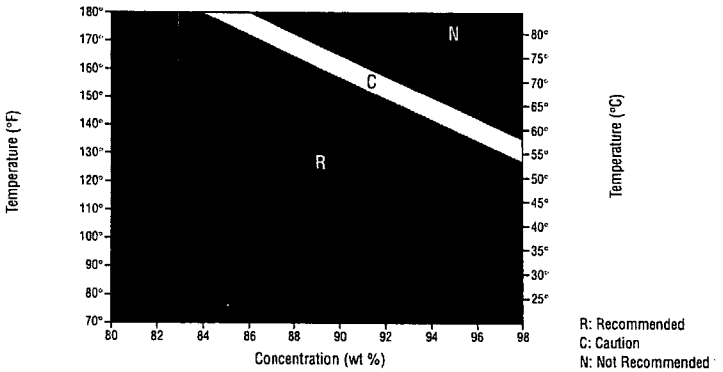
Certain organic solvents which are soluble with water, such as alcohols, may safely be handled below a certain concentration. Many of these limiting concentrations are noted in Table 1. Solvents which are insoluble in water, such as aromatics, will be absorbed by the piping over time, even when they are present at very low levels in the water. This will lead to a decreased service life expectancy for the system.

The full hydrostatic pressure rating of the pipe may not apply to the entire range of temperature and concentration designated as "recommended".

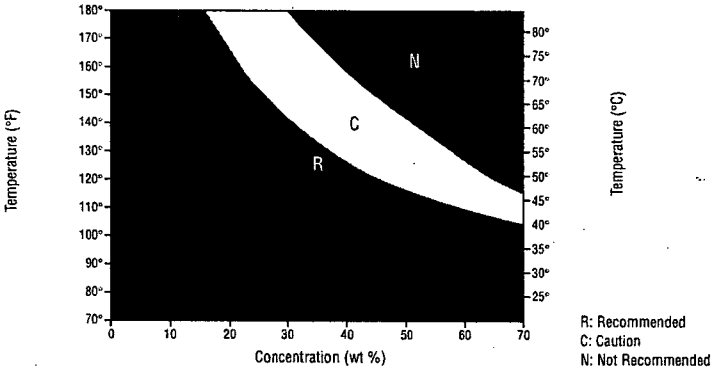
CPVC is not recommended for fuming acid service.

Contact your piping supplier or Noveon for consultation and/or the latest chemical resistance information.

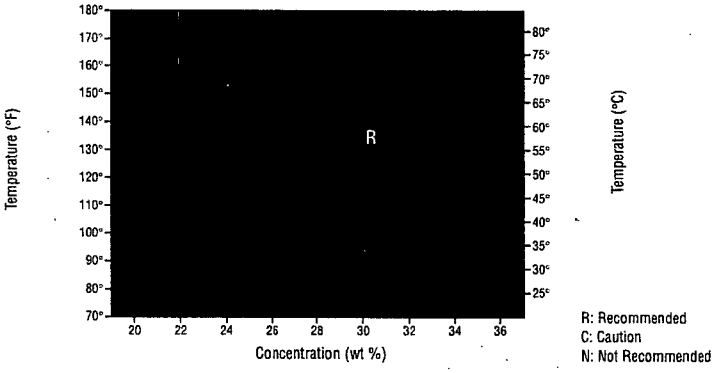
Chemical Resistance of Corzan® CPVC to Sulfuric Acid



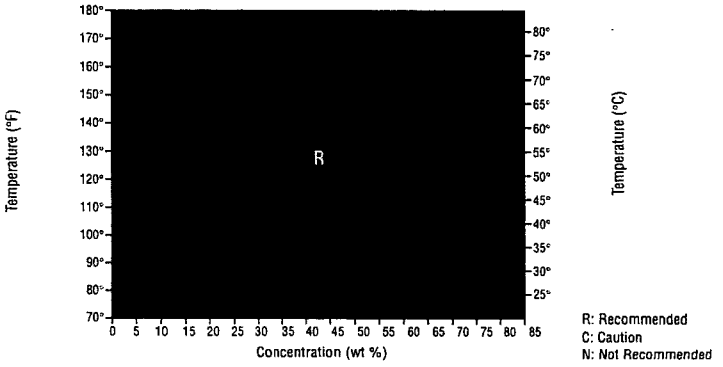
Chemical Resistance of Corzan® CPVC to Nitric Acid



Chemical Resistance of Corzan® CPVC to Hydrochloric Acid



Chemical Resistance of Corzan® CPVC to Phosphoric Acid



noveon

The Specialty Chemicals Innovator™

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December 2002
G2-35

Design, Specification, & Installation

Chemical Compatibility

Updated: November 29

Supercedes: August 16

Corzan® Pipe & Fittings

CPVC domestic water, fire sprinkler, and industrial piping systems have been used successfully f more than 40 years in new construction, re-pipe and repair. CPVC products are ideally suited foı applications due to their outstanding corrosion resistance. Occasionally, however, CPVC and PVC be damaged by contact with chemicals found in some construction products (and site preparatio Reasonable care needs to be taken to insure that products coming into contact with CPVC systeı chemically compatible. Noveon recommends that chemical compatibility with CPVC be confirmec the manufacturer of the product in contact with CPVC piping systems. If chemical compatibility ı CPVC is in question, Noveon recommends isolating the suspect product from contact with CPVC fittings.

The following products have been shown to be **UNACCEPTABLE** for (unprotected use) contact ı CPVC systems. Chemically incompatible products are added to this list as they are brought to oı attention. A product's absence from this list does not imply or insure CPVC chemical compatibilit **ALWAYS CHECK THE PRODUCT MANUFACTURER'S RECOMMENDATION IN THIS REGARI**

UNACCEPTABLE PRODUCTS - Do Not Use

CATEGORY	COMPANY	PRODUCT
Caulks	OSI Sealants (Dartworth Company) (Ohio Sealants)	Polyseamseal Tub & Tile Adhesive Caulk Polyseamseal All Purpose Adhesive Caul Pro Series PC-158 Caulk
	John Wagner Associates	Grabber Acoustical Sealant GSCS
	White Lightning	3006 All Purpose Adhesive Caulk
Fire Stopping Systems	3M	Fire Barrier 2003 Silicone Fire Barrier CP25WB+
	Flame Stop	Flame Stop V
	Proset	Proseal Plug, Black Proseal Plug, Red
Leak Detector	Federal Process Co.	Gasoila Leak Tech*

		*Gasoila Leak Tech Gold **is** FlowGuard Gold®, BlazeMaster®, and Corzan® CPVC compatible.
Miscellaneous	WD40	WD40 lubricant
	Victaulic	Silicone Pipe Lubricant
		Peppermint Oil
		Roofing Tar
		Vaseline
		Vegetable Oils
Pipe Clamp	LSP Specialty Products	Acousto Clamp, Acousto-Plumb System
	Naylon Products	Naylon vinyl-coated wire pipe hangers
Pipe Tape	Christy's	Pipe Wrap Tape
	Pro Pak, Inc.	Pipe wrap tape (black)
	Pasco	All Weather PVC Pipe Wrap
	Wonder	No. 413 Pipe Wrap Tape
Thread Sealants	Allied Rubber & Gasket Company (ARGCO)	Super Dope
	Anti-Seize Technology	TFE Paste
	Devcon	Super Lock Hi-Strength, Stud Lock Grac 2271
	General Sealant	GS-600
	G.F. Thompson Co., Ltd.	Masters™ Pro-Dope™ with Teflon®
	Hercules	Brush-on/Blue Block
	Hernon Mfg. Inc.	Powerseal #932
	JC Whitlam Mfg. Co.	Seal Unyte Thread & Gasket Sealer
	Jet Lube, Inc.	Jet Lube V-2
	Jomar	Tighter-than-Tite
	Locktite	Threadlocker 242
	Lyn-Car Products Ltd.	Proseal
	National Starch & Chemical, Permabond Division	Permabond LH-050 Permabond LH-054
	Permatex Company, Inc.	Permatex 14H
	Rule	High Performance Teflon Thread Sealing Compound
	Saf-T-Lok Chemcial	Saf-T-Lok TPS Anaerobic Adhesive/Seal Industrial Grade TPS
	Swagelock Company	SWAK

TERMITICIDES & INSECTICIDES

- When performing installations underslab or where the presence of insecticides or termitici likely, care should be taken to isolate CPVC pipe from direct contact with heavy concentra of these chemicals. Vinyl piping materials such as PVC or CPVC may be damaged when termiticides or insecticides are injected into the annular space between the pipe wall and sleeving material trapping the termiticide against the pipe wall. Termiticide applications p label instructions in an open-air environment, such as slab pretreat applications, should n pose a problem. However, puddling of termiticides on or near CPVC pipe may cause failur areas where puddling is more likely, such as areas near tub boxes and retreat application extra care should be taken to avoid puddling of termiticides. Exercising caution and comn sense will prevent installation problems. For more information, review your manufacturer installation guide.

- Additional precautions need to be taken when retreat applications are required. Termiticic retreatment is usually required when the concrete slab has been broken to relocate a pipe following recommendations should followed in retreat applications:
  - Remove all the plastic barrier material that was installed prior to the initial concrete pou the area to be retreated. Do not reinstall the plastic barrier material.
  - After the pipe has been relocated, the soil should be pretreated before it is placed in hol around the pipe. Do not apply termiticide directly to the retreat area.
  - Termiticides that contain cypermethrin should not be used in retreat applications.

- In situations where sleeving is required, the pipe should be protected with a compatible sleeving material extending at least 12" above and below the soil. The top of the sleeving should be securely taped to the pipe with a compatible tape product. Backfill over underg piping prior to termiticide spraying.

NOTE:

- Noveon recommends Teflon® tape as the preferred thread sealant.

- Noveon also publishes a more complete listing covering application of individual compour This may be found in the Noveon Chemical Resistance Chart for CPVC Piping Products. Tl user is also encouraged to compare data from the individual product's MSDS to the publi: Chemical Resistance Chart.

- Prolonged direct contact with flexible wire and cable that ulitize insulation containing plasticizers is not recommended. Section 334.30 of the National Electric Code (2002 Editi requires wire and cable to be secured by staples, cable ties, straps, or hangers. Air ducts pipes and ceiling grid are not acceptable supports for wire and cable.

- HVAC applications - Some heat exchangers or condenser coils may contain residual oils f the manufacturing process which can cause cracking of CPVC. Caution should be exercise

when installing CPVC in combination hot water/air heating units or as condensate drain li for air conditioning systems. Confirm the compatibility of CPVC with the residual oils prio installation. The interior of heat exchangers or the exterior of condenser coils may be thoroughly flushed with mild detergent solution to remove incompatible oils prior to pipin installation. A rinse with clean water to completely clean the system is advisable as a fin flushing.

- Primers, cleaners, and solvent cements containing appreciable amounts of acetone may rapid environmental stress cracking of CPVC metal insert parts during installation at free: temperatures. Contact your primer/cleaner/solvent cement manufacturer for more inforn or recommendation of alternatives.

- When CPVC pipe is installed in kitchen areas the pipe must be protected from contact wit grease or cooking oils. Consideration must be given to not only protecting the pipe from contact with grease or oil as well as contact that may occur from airborne grease or oil.

- When performing repairs to leaks in existing systems, care should be taken to isolate CP pipe from direct contact with heavy concentrations of fungicide products which may be a during cleanup of water damage. Vinyl piping materials such as PVC or CPVC may be dar by fungicides when fungicides are sprayed on surrounding drywall and wood framing to prevent the growth of mold and mildew in the affected area. Common sense precautions prevent problems with repairs to existing systems. When repairs are made to an existing system, and the possibility exists that fungicides will be applied to treat damp drywall an wood framing surrounding the repair site, exposed piping should be sleeved with a comp plastic sleeving or pipe insulation material to prevent direct contact of the fungicide with plumbing system.

Please click on the following links for information on specific chemicals.

Chemical Resistance Table
Common Acids Only
Common Bases Only

Download Corzan® CPVC Chemical Resistance Brochure in

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Plastic pipes and fittings for home and industrial use

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Parent Case Text:

CROSS-REFERENCE

[0001] This is a continuation-in-part of Ser. No. 09/134,026 filed Aug. 14, 1998, now abandoned, which was a continuation of Ser. No. 08/565,910 filed Dec. 1, 1995, now abandoned.

Abstract: Plastic pipes, fittings and other piping appurtenances prepared from CPVC formulations meeting requirements of ASTM-D 1784, cell class 23448-B, yet exhibiting suitable processability.

Summary of the Invention:

BACKGROUND OF THE INVENTION

[0002] The invention relates to pipes, fittings and other piping appurtenances prepared from unique CPVC formulations. These formulations provide an improved combination of physical properties including heat deflection temperature, impact strength, tensile strength and modulus of elasticity. More particularly, the formulations meet requirements of ASTM-D 1784, cell class 23448-B, while maintaining suitable processability.

FIELD OF THE INVENTION

[0003] Plastic-type pipes, fittings and other piping appurtenances are an attractive alternative to those made of metal. One type is prepared from rigid poly(vinyl chloride) (PVC) formulations, and another is prepared from rigid chlorinated poly(vinyl chloride) (CPVC) formulations. These formulations are usually intended for use in an extruded or molded form.

[0004] CPVC is known to have excellent high temperature performance characteristics, among other desirable physical properties. Typically, commercial CPVC has an excess of about 57 percent by weight of bound chlorine, and is most conveniently made by the chlorination of poly(vinyl chloride) (PVC). See U.S. Pat. Nos. 2,996,489; 3,100,762; 3,334,077; 3,334,078; 3,506,637; 3,534,013; 3,591,571; 4,049,517; 4,350,798; 4,377,459; 4,412,898; and 4,459,387.

[0005] CPVC has become an important specialty polymer due to its relatively low cost, high glass transition temperature, high heat distortion temperature, outstanding flame and smoke properties and chemical inertness. The glass transition temperature of CPVC generally increases as the amount of chlorine increases. However, it is well known that CPVC resins have low impact properties. Also, as the chlorine content increases, the CPVC resin becomes more difficult to melt process, and becomes more brittle.
[0006] The increasing demand for CPVC pipes, vessels, valve bodies and fittings, and the fact that an impact-deficient CPVC matrix can be improved by compounding and blending it with other polymers, has provided significant incentive to develop better impact modified CPVC formulations having increased heat distortion temperatures, and increased ease of melt-processing. Most of these efforts have been directed toward rigid CPVC applications where acceptable impact strength and dimensional stability under heat are critical. These include the manufacture of exterior structural products, rigid panels, pipes and conduits, injection-molded and thermoformed industrial parts, appliance housings, and various types of containers, both large and small. Examples include those formulations of U.S. Pat. Nos. 3,264,375; 3,882,192; 3,886,235; 3,991,009; 4,105,711; 4,173,598; 4,362,845; 4,399,093; 4,443,585; 4,504,623; 4,504,624; 4,617,329; 4,663,375; 4,680,343; 4,766,177; 4,769,901; 4,786,350; 4,787,135; and 5,268,424.
[0007] For piping applications, ASTM-D 1784 sets forth the standard specifications for rigid CPVC formulations. They are identified in terms of cell classifications indicative of certain physical properties of the formulations. Cell class 23447-B is indicative of certain current commercially available CPVC formulations. The first digit (2) identifies the base resin as CPVC. The second (3) and third (4) digits identify impact strength and tensile strength characteristics, respectively. And the fourth (4) and fifth (7) digits identify modulus of elasticity and deflection temperature characteristics, respectively. The suffix designation (B) is indicative of a formulation's chemical resistance. Thus, those current commercial formations have the following properties according to ASTM-D 1784.
(table - see patent image)
[0008] It is desirable to increase heat deflection temperatures of CPVC formulations to levels higher than those provided by compositions of cell class 23447-B, i.e., to levels higher than 212 degree F. (100 degree F.). Doing so, however, result in a general degradation of one or more of those other physical properties characteristics of 23447-B formulations. For example, simply increasing chlorine content degrades impact strength levels below those mandated by ASTM-D 1784, cell class 23447-B. Adding or changing impact modifiers to compensate can degrade tensile strength and modulus of elasticity.
[0009] Even if those other cell class 23447-B properties are maintained at allowable levels, processability of the CPVC composition must also be maintained. An effective formulation for fluid handling applications must be moldable or extrudable. That is, a formulation can not degrade when processed in the manner required for extrusion or molding.
[0010] It is the object of the invention, therefore, to provide a moldable or extrudable CPVC formulation having a deflection temperature in excess of 212 degree F. (100 degree F.) while maintaining impact strength, tensile strength and modulus of elasticity at the same levels required of a cell class 23447-B formulation.
SUMMARY OF THE INVENTION

[0011] The invention provides pipes, fittings and other piping appurtenances, prepared from a moldable or extrudable CPVC formulation having a deflection temperature higher than 100 degree C. (212 degree F.). The formulations exhibit suitable processability, and meet requirements of ASTM-D 1784, cell class 23448-B. That is, the formulations have a deflection temperature of at least 110 degree C. (230 degree F.) yet maintain most, and in some cases all the other properties of a cell class 23447-B formulation.

[0012] Another aspect of the invention relates to pipes, fittings and other piping appurtenances prepared from such formulations which also meet the requirements of ASTM-D 2846 for home water handling and ASTM-F 438 and F 439 for industrial fittings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

[0013] Plastic pipes, fittings and other piping appurtenances according to the invention are prepared from CPVC formulations which meet the requirements of ASTM D 1784, cell class 23448-B. Such formulations have as their primary component a CPVC resin having a specified weight percent of chlorine of at least about 70%, and up to about 73%, preferably about 70 to 72%.

[0014] Suitable CPVC resins are resins having an inherent viscosity of about 0.60 to about 1.0, preferably about 0.65 to about 0.72. Such resins should also have a fused density of about 1.59 to about 1.68, preferably about 1.60 to about 1.67. Examples of such CPVC resins include TempRite 677X670, TempRite 657X612 and TempRite 677X705, available from Noveon, Inc. When the term inherent viscosity (IV) is used to describe the CPVC resins as above, technically it is the IV of the PVC resin used to make the CPVC. IV is not usually measured on the CPVC resin after the PVC has been further chlorinated to make CPVC resin. IV is defined in ASTM D-1243 as the ratio of the natural logarithm of the relative viscosity of a resin and the concentration of the solution used to measure the viscosity. ASTM D-1243 as measured herein on the PVC resin used to make the CPVC resin employs a 0.2 gram sample of PVC resin in 10 ml of cyclohexanone at 30 degree C. IV is a measurement of molecular weight and relates to K-value and degree of polymerization. The IV in this invention was determined using ASTM D-1243 on the PVC resin before it was chlorinated to make CPVC resin.

[0015] CPVC is known to the art and to the literature and is commercially available. CPVC can be made by any commercial chlorination process or the like, such as by a solution process, a fluidized bed process, water slurry process, thermal process, or a liquid chlorine process. The only limitation is that care must be taken to select those resins, or use those processes to prepare the resins, which will provide CPVC resins with the chlorine content, density and viscosity characteristics described above.

[0016] In theory, a CPVC resin used according to the invention may be blended with or contain generally small amounts of PVC and/or PVC copolymers. The amount of PVC homopolymer or copolymer could range from about 1% to about 50%. However, it is preferred that no amount of PVC homopolymer or copolymer be contained in the CPVC formulations according to the invention.

[0017] It is also possible that CPVC can be blended with another CPVC polymer. In those instances, the CPVC resin can be blended with another CPVC resin in an amount of other resin of about 1% to about 50%. Again, however, no amount should be added which would affect properties of the resin such as chlorine content which are necessary to

obtain a formulation meeting the requirements of cell class 23448-B. It is preferred that a blend of CPVC resins not be used.

[0018] The CPVC formulations according to the invention should contain an impact modifier selected such that the tensile strength and modulus of elasticity will not be degraded below those levels required of cell class 23448-B formulations. Likewise, the formulation should exhibit suitable processability.

[0019] Since impact modifiers will tend to degrade other properties of the cell class (tensile strength and modulus), care must be used in their selection. As used herein, therefore, useful impact modifiers are only those which will not degrade cell class properties below the limits of ASTM-D 1784, cell class 23448-B, or processability. Such suitable impact modifiers include higher rubber (butadiene) content and high efficiency methylmethacrylate-butadiene-styrene (MBS) impact modifiers such as those sold under the name Kaneka B-22 and B-56 by Kaneka-America. Other MBS impact modifiers, as well as acrylonitrile-butadiene-styrene (ABS) impact modifiers, could be useful so long as cell class and processability is maintained. Examples include those sold under the names Metablen C-224 by Atochem, Acryloid KM-680 or BTA-751 by Rohm & Haas, or Blendex 310 or 338 by General Electric. It is not necessary for formulations according to the invention to contain any polyorganosiloxane-containing impact modifier. Suitable impact modifiers can be used in an amount of about 3 to about 15 phr, preferably about 5 to about 10 phr.

[0020] CPVC formulations according to the invention are extrudable or moldable, i.e., they exhibit "suitable processability". Formulations according to the invention which exhibit suitable processability are those CPVC formulations which exhibit a melt flow index of at least about 1.0, preferably at least about 5.0 grams/10 minutes, and a dynamic thermal stability (DTS) time of at least about 1.0 minute, preferably at least 3.0 minutes at 235 degree C/35 r/min. Most preferred CPVC formulations according to the invention which exhibit suitable processability would have a melt flow index of at least about 1.0 gm/10 minutes, and even up to about 25 gm/10 min, or more, and/or a DTS time of at least 5 minutes, even more preferably at least 7 minutes at 235 degree C./35 r/min.

[0021] Melt flow rate is a standard measure of the rate of extrusion of molten resins through a die of a specified length and diameter under prescribed conditions of temperature, load and piston position in the barrel as the timed measurement is being made. See ASTM-D 1238. As used herein, the flow rate is expressed in terms of grams/i 0 minutes. The melt flow index for standard CPVC is normally measured at 215 degree C. for standard CPVC formulations, and is measured at 235 degree C. for the higher heat CPVC formulations according to the invention. In both cases, the standard load is 21,600 grams. Either method A (manual) or method B (automatic) as specified in ASTM-D 1238 can be used.

[0022] Dynamic thermal stability (DTS) is also a measure of processability. The DTS test is designed to measure the time-torque relationship of a particular formulation at selected temperatures using an instrument such as the Brabender Plasti-corder. See ASTM-D 2538. The test value generally reported, and used for comparison, is the "DTS time". Unless specified otherwise, DTS time is defined herein as the time at a particular temperature/rotor speed, herein 235 degree C./35 r/min, required for the instrument torque to fall to is minimum value, with the polymer compound in the melted state, before beginning to increase, presumably due to instability and usually accompanied by

autogenous cross-linking. As noted above, formulations according to the invention exhibit DTS time of at least 1.0, preferably 3.0 minutes under such conditions.

[0023] Other components may be present in formulations of the present invention. These include, for example, antioxidants, lubricants, stabilizers, impact modifiers, tinting colorants, blueing agents, pigments, Tg enhancing additives and processing aids, all of which serve various purposes known in the PVC compounding art. But no additive should be used which alters the unique combination of physical properties and processability associated with formulations according to the invention. For example, no additive should be used which degrades impact strength below those levels characteristic of cell class 23448-B. Likewise, no impact modifier should be used which degrades tensile strength and modulus of elasticity below the levels of that cell class. Nor should any additive be used which reduces processability below suitable levels.

[0024] Exemplary lubricants are polyglycerols of di- and trioleates, polyethylene, oxidized polyethylene, and high molecular weight paraffin waxes and mixtures thereof. Specific examples are oxidized polyethylenes such as those sold under the trade name AC 629 by Allied Signal, the paraffin waxes, such as those sold under the trade name Hostalube 165 by Hoechst Celanese. Lubricants can be used in an amount of about 0.01 to 5, preferably about 0.4 to about 2.0 parts per hundred resin (phr). Specific lubricants and their commercial sources are available by reference to Chemical Week-Buyers Guide.

[0025] Suitable heat stabilizing ingredients include phosphate stabilizers such as disodium phosphate, maleimides, sulfur compounds and alkyltin compounds. Tin compounds include methyltin, octyltin, mixed metal alkyltins, dialkyl tin dicarboxylates, methyl tin mercaptides, butyltin mercaptides, dialkyl tin bis(alkyl mercaptocarboxylate) including di-n-octyltin-S,S'-bis (isoctyl mercaptoacetate), butyl thiostannoic acid, and other ester tins. Di-C[sub]4-C[sub]8 alkyl tin stabilizers such as C[sub]4 to C[sub]8 alkyl tin carboxylates are preferred. A particularly preferred stabilizer is a tin thioglycolate such as that sold under the trade name Mark 292-S by Witco Chemical. Use levels can be in the range of about 1 to about 5.0, preferably about 2.0 to about 4.0, phr.

[0026] Suitable processing aides include acrylic polymers such as methyl acrylate copolymers. A specific acrylic process aid is the acrylate sold under the name Acryloid KM(R) 330, by Rohm and Haas, Inc. Other processing aids are disclosed in The Plastics and Rubber Institute: International Conference on PVC Processing, Apr. 26-28 (1983), Paper No. 17. There are embodiments of the invention containing no such processing aids, but if such processing aids are used they should be added in an amount of up to about 4.0, preferably 0.5 to about 3.0, phr.

[0027] However, another aspect of the invention involves the absence of chlorinated polyethylene (CPE). The use of small amounts of CPE (up to 10 phr) can maintain the heat distoration temperature, but can reduce tensile strength and modulus and thus not meet all of the requirements of ASTM-D 1784, cell class 23448-B. Examples of such CPE additives which should not be used include Tyrin (R) 3611P sold by the Dow Chemical Company. The compositions of this invention should be substantially free of CPE (less than about 1.0 phr). Most preferred, the compositions are free of CPE.

[0028] It has been found for certain embodiments of the invention that lower molecular weight CPVC resins can function as a process aid, i.e., those having an inherent viscosity

in the range of about 0.45 to about 0.60, preferably about 0.50 to about 0.56. Specific examples include TempRite 679X705 sold by Noveon, Inc.

[0029] If used, a lower molecular weight CPVC resin should be blended in an amount of up to 50 weight % based on the total amount of CPVC resin, preferably about 10 to about 30%, and more preferably about 10 to about 20%. The most preferred embodiment is 0% low molecular weight CPVC. Such low molecular weight CPVC resins will not adversely affect physical properties and will improve appearance and processability.

[0030] Examples of antioxidants include Irganox 1010 (tetrakis[methylene(3,5-di-tert-butyl-4-hydroxyhydrocinnamate)] methane) sold by Ciba Geigy. These components increase thermal stability and are used in the art primarily for cosmetic reasons, i.e., for delaying color changes. If used, such components may be used in an amount ranging from 0.25 to about 5, preferably about 0.5 to about 1.0, phr.

[0031] Suitable pigments include, among others, titanium dioxide, calcium carbonate, talc, clay, mica and carbon black. Such pigments can be added in amounts ranging from about 0.001 to about 10.0, preferably about 0.01 to about 5.Q, and most preferably up to about 1.0 phr.

[0032] The CPVC formulations can be made in any manner wherein the various components are added together and mixed under heat. For example, the appropriate amount of CPVC resin can be added to a vessel. The remaining ingredients can then be added thereto and mixed. Melt mixing can generally occur at temperatures of from about 150 to about 250 degree C. (300 to 500 degree F.). Once the blend is formed, it can be processed in any conventional manner, e.g., using conventional extrusion or molding techniques.

[0033] To obtain a more complete understanding of the present invention, the following examples illustrating certain aspects of the invention are set forth. It should be understood, however, that the invention is not limited in any way to the specific details set forth therein.

Description of the Invention:

EXAMPLES

[0034] Various formulations were prepared to demonstrate certain aspects of the invention. The first formulation, i.e., formulation A, was prepared for comparison purposes, and represents a formulation meeting the requirements of cell class 23447-B and exhibiting suitable processability, but not meeting the requirements of cell class 23448-B. Formulation B meets all of the requirements of cell class 23448-B and demonstrates this invention. Formulations C, D and E are CPVC formulations which are comparative examples which contain CPE and do not meet all of the requirement of ASTM D-1784, cell class 23448-B. The specific components for each formulation are set forth in Table 1, and properties exhibited by the formulations are set forth in Tables 2, 3 and 4. Formulation A was processed and tested at conditions normal for standard CPVC molding compositions (215 degree C.), while Formulations B, C, D and E were processed and tested at conditions normal for high heat CPVC molding compositions according to the invention (235 degree C.).

[0035] For formulation A, a CPVC resin was used having an inherent viscosity of 0.68, a chlorine content of 67%, and a fused density of 1.565 grams/cc. Formulations B and C were prepared with a CPVC resin having an inherent viscosity of 0.68, a chlorine content

of 70%, and a fused density of 1.607 grams/cc. Formulation D was prepared with a CPVC resin having an inherent viscosity of 0.68, a chlorine content of 70.5%, and a fused density of 1.620 grams/cc. Formulation E included a blend of the same CPVC resin used for formulations B and C, and a lower molecular weight CPVC resin in a 75/25 split of high molecular weight to low molecular weight resin. The lower molecular weight resin had an inherent viscosity of 0.51-0.54, a chlorine content of 70.5% and a fused density of 1.618 grams/cc.

[0036] The CPVC resins for each of Formulations A, B, C, D and E were blended together with the additives and in the amounts indicated below in Table 1. The formulations were then tested for the properties set forth in Tables 2, 3 and 4.

(table - see patent image)

[0037]

(table - see patent image)

[0038]

(table - see patent image)

[0039]

(table - see patent image)

[0040] From the data shown above, it can be seen that only Formulation B meets all of the requirements of ASTM-D 1784, cell class 23448-B.

[0041] While the invention has been described above in terms of preferred embodiments, it is to be understood that variations and modifications may be used as will be appreciated by those skilled in the art. Such variations and modifications are to be considered within the scope of the invention as defined by the following claims.

What is claimed is:

1. An extruded pipe, or a molded or extruded fitting or other piping appurtenance prepared from a CPVC formulation exhibiting suitable processability and meeting the base resin, impact strength, heat deflection temperature, tensile strength, and tensile modulus requirements of ASTM-D 1784, cell class 23448-B, with the proviso that said CPVC formulation is substantially free of chlorinated polyethylene.

7. A CPVC formulation comprising: a CPVC resin having a chlorine content of at least 70% by weight and characterized by an inherent viscosity of about 0.60 to about 1.0, from about 3 to about 15 phr of a high rubber content MBS and/or ABS impact modifier, said formulation meeting the base resin, impact strength, heat deflection temperature, tensile strength, and tensile modulus requirements of ASTM-D 1784, cell class 23448-B, with the proviso that said CPVC formulation is substantially free of chlorinated polyethylene. (Main Claim)

2. A pipe, fitting or other piping appurtenance according to claim 1, prepared from a CPVC formulation comprising a CPVC resin having a chlorine content of at least 70% by weight and an inherent viscosity of about 0.65 to about 0.72, and a high rubber content and high efficiency MBS impact modifier, said CPVC formulation having a melt flow index of about 1 to about 20g/10 minutes and a DTS time of at least 3 minutes at 235 degree C./35 r/m.

3. A pipe, fitting or other piping appurtenance according to claim 2, prepared from a CPVC formulation having a melt flow index of about 5 to about 20 g/10 minutes, and a DTS time of at least 5 minutes.

4. A pipe, fitting or other piping appurtenance according to claim 1, meeting the acid weight gain requirements of ASTM-D 1784, cell class 23448-B.
5. A pipe, fitting or other piping appurtenance according to claim 3, wherein said formulation further comprises a lower molecular weight CPVC resin having an inherent viscosity of about 0.45 to about 0.60, in an amount of about 10 to about 20 weight %.
6. A pipe, fitting or other piping appurtenance according to claim 2, wherein said formulation comprises a CPVC resin with a chlorine content of about 70 to about 73% by weight and an inherent viscosity of about 0.65 to about 0.72, about 2 to about 4 phr of tin stabilizer(s), about 5 to about 10 phr of MBS impact modifier(s), up to about 3 phr of acrylic process aid(s), about 0.4 to about 5 phr lubricant(s), and about 0.25 to about 1.0 phr antioxidant(s).
8. A CPVC formulation according to claim 7, meeting the acid weight gain requirements of ASTM-D 1784, cell class 23448-B.
9. A CPVC formulation according to claim 7, comprising a CPVC resin having a chlorine content of at least 70% by weight and an inherent viscosity of about 0.65 to about 0.72, and a high rubber content and high efficiency MBS impact modifier, said CPVC formulation having a melt flow index of about 1 to about 25g/10 minutes and a DTS time of at least about 3 minutes at 235 degree C./35 r/m.
10. A CPVC formulation according to claim 7, comprising a CPVC resin having a chlorine content of at least 70% by weight and an inherent viscosity of about 0.65 to about 0.72, and a high rubber content and high efficiency MBS impact modifier, said CPVC formulation having a melt flow index of about 5 to about 20 g/10 minutes and a DTS time of at least about 5 minutes.
11. A CPVC formulation according to claim 9, further comprising a lower molecular weight CPVC resin having an inherent viscosity of about 0.45 to about 0.60, in an amount of about 10 to about 20 weight % of total CPVC resin.
12. A CPVC formulation according to claim 9, comprising a CPVC resin with a chlorine content of about 70 to 73% by weight, about 2 to about 4 phr of a tin stabilizer(s), about 5 to about 10 phr of MBS impact modifier(s), up to about 3 phr of acrylic process aid(s), about 0.4 to about 5 phr lubricant(s), and about 0.25 to about 1.0 phr antioxidant(s), and containing no polyorganosiloxane-containing impact modifier.
13. A CPVC formulation according to claim 7, further comprising a lower molecular weight CPVC resin having an inherent viscosity of about 0.45 to about 0.60, in an amount of about 10 to about 20 weight % of the total CPVC resin.
14. A CPVC formulation according to claim 9, in the form of a fitting or piping appurtenance.
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