Comments of

COALITION FOR SAFE BUILDING MATERIALS

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

In Opposition To

The Proposed Amendment of CPC Sections 604.1, 604.1.1, 604.11, 604.11.1, 604.11.2, 604.13, 604.13.1 and 604.13.2 to Allow the Statewide Approval of PEX and PEX-AL-PEX Drinking Water Pipe

VOLUME I

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Re: Opposition to Proposed Amendment of CPC sections 604.1, 604.1.1, 604.11, 604.11.1, 604.11.2, 604.13, 604.13.1 and 604.13.2 to allow the Statewide Approval of PEX and PEX-AL-PEX

Dear Mr. Morrison:

The following comments opposing the proposed adoption of California building standards approving the use of PEX and PEX-AL-PEX for potable water piping are respectfully submitted on behalf of the Coalition for Safe Building Materials ("Coalition"). The Coalition members include the Sierra Club, the Planning and Conservation League, Communities for a Better Environment, the Consumer Federation of California, the Center for Environmental Health, the California Professional Firefighters and the California Pipe Trades Council. The environmental, consumer, public health and labor organizations that make up the Coalition represent literally millions of Californians concerned about the safety of new building materials.

The Coalition's comments include and incorporate by reference the expert comments of Thomas Reid Associates and Dr. Robert Clark, attached as Exhibits A through G to this letter. These comments also reference a number of supporting technical documents that are submitted as separately bound appendices. The supporting Appendix is also incorporated by reference and hereby made a part of the comments of the Coalition.

We thank you and the Commission for this opportunity to comment.

Sincerely,

Thomas A. Enslow

TAE:cnh
Attachments

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I. INTRODUCTION

The California Building Standards Commission ("CBSC" or "Commission") is currently reviewing proposed building standard code submittals as part of its annual code adoption cycle. Included in the Monograph of Code Change Submittals ("Monograph") currently under review are regulations proposed by the Department of Housing and Community Development ("HCD") that would amend the current California Plumbing Code ("CPC") to permit the use of Crosslinked Polyethylene ("PEX") and PEX-AL-PEX for potable water piping in all residential occupancies. In addition, CBSC and the Division of the State Architect ("DSA") have proposed the adoption of regulations that would permit the use of PEX-AL-PEX (but not PEX) for potable water piping in occupancies under their jurisdiction.

There is substantial evidence that the approval of PEX and PEX-AL-PEX piping for potable water plumbing systems may result in significant public health and environmental impacts. Accordingly, the proposed regulations approving these products may not be adopted until these potential impacts have been fully disclosed, analyzed and mitigated in an environmental impact report ("EIR") as required by the California Environmental Quality Act ("CEQA"). Nonetheless, HCD, CBSC and DSA have made no attempt whatsoever to comply with CEQA prior to moving forward with the adoption these standards.

This failure is particularly egregious since it violates the Court of Appeal's order in the recent case *Plastic Pipe and Fittings Association v. the California Building Standards Association* (*PPFA v. CBSC*). (*PPFA v. CBSC* (2004) 124 Cal.App.4th 1390.) The court in that case held that compliance with CEQA is required prior to the adoption of building standards that would approve the use of PEX. CBSC, HCD and DSA were all parties to this case. Accordingly, the court's holding is binding upon these agencies both as published case law and under the

doctrine of collateral estoppel. Defiance of this holding would not only be illegal, but tantamount to contempt of court.

We ask merely that the Commission comply with the court's holding in the *PPFA v. CBSC* case and deny adoption of the proposed PEX and PEX-AL-PEX regulations until environmental review under CEQA has been completed. Because there is substantial evidence that the approval of PEX and PEX-AL-PEX drinking water pipe may result in significant public health and environmental impacts, compliance with CEQA requires the preparation of an EIR. These potential impacts include:

- Contamination of drinking water due to the leaching of chemicals such as MTBE and tert-Butyl alcohol in amounts that exceed the state standards for taste, odor and health (industry standards allow for the production of PEX pipes that leach as much as 50 ppb of MTBE, while California has set a taste and odor standard of 5 ppb and a health standard of 13 ppb);

- Contamination of drinking water due to the permeation of PEX piping by pesticides, termiticides, benzene, gasoline constituents and other toxic chemicals;

- Premature degradation and rupture of PEX pipe due to exposure to numerous commonly encountered materials and environmental conditions, including sunlight, high temperatures, chlorine, petroleum products, firestopping material and asphalt;

- Increased risk of biofilm formation containing dangerous pathogens such as Legionella (copper acts as a biocide, killing these pathogens, while PEX and PEX-AL-PEX promote the growth of these pathogens);

- Increased solid waste disposal impacts since PEX is a thermoset plastic which is virtually impossible to recycle (a report by the City of San Francisco Department of Environment found that PEX was the only plastic that no plastic recycler would accept); and

- Increased risk of fire hazard from toxic smoke and fire spread.

The proposed adoption of the PEX and PEX-AL-PEX standards must also be denied because the Monograph fails to meet the notice and justification requirements of Health and Safety Code section 18929.1. Section 18929.1 requires that the public be given adequate written notice and opportunity to comment on the proposed building standards and their justification. Section 18929.1 further requires that these proposed procedures meet the intent of the Administrative Procedure Act ("APA") and of Health and Safety Code section 18930 of the California Building Standards Law.

Health and Safety Code section 18930 requires that building standards be justified under the listed nine-point criteria. The Monograph, however, fails to provide the public with the Agencies' nine-point criteria analysis. As a result, the public is prevented from reviewing and commenting on the justification for these regulatory proposals.

Furthermore, the proposed approval of PEX and PEX-AL-PEX would not meet at least two of the nine-point criteria: (1) the requirement that the adoption of standards be in the public interest; and (2) the requirement that the adoption of standards would not be unreasonable, arbitrary or unfair. Because the proposed adoption of PEX and PEX-AL-PEX would violate state law, defy the court's holding in *PPFA v. CBSC* and potentially result in numerous public health, safety and environmental impacts, adoption of these standards would be contrary to the public interest and unreasonable, arbitrary and unfair.

The Monograph is also procedurally defective under the APA because it fails to clearly identify the proposed addition of PEX-AL-PEX to the existing California Building Standards Code and fails to provide a rationale for the approval of PEX-AL-PEX. Moreover, HCD's Initial Statement of Reasons supporting the approval of PEX lacks evidentiary support and is contrary to the unrebutted substantial evidence before the Commission.

It is critical to the health and safety of the California public that the potential impacts of PEX and PEX-AL-PEX be fully disclosed, evaluated and mitigated before these materials are approved for use throughout California. The proper forum for such evaluation is an EIR. Furthermore, the Commission must ensure that the adoption process complies with the procedural requirements of the California Building Standards Law and the APA.

II. THE PROPOSALS TO PERMIT THE USE OF PEX AND PEX-AL-PEX SHOULD BE DISAPPROVED OR TABLED PENDING FURTHER STUDY

A. The HCD Proposals to Approve the Use of PEX and PEX-AL-PEX Should Be Disapproved or Tabled Pending Further Study

HCD has proposed the adoption of building standards that would amend the current California Plumbing Code to permit the use of PEX and PEX-AL-PEX for potable water piping. (California Building Standards Commission, *Monograph of Code Change Submittals for 2004 Annual Code Adoption Cycle, Suggested Revisions to the California Building Standards Code Title 24* ("Monograph") (May 2004) pp. 3-207, 3-208, 3-243.) The specific HCD proposals that would approve the use of PEX and PEX-AL-PEX are contained in the proposed amendments to CPC sections 604.1, 604.1.1, 604.11, 604.11.1, 604.11.2, 604.13, 604.13.1 and 604.13.2. These proposed regulations have been submitted to the Commission for review and public comment as required under the California Building Standards Law and the APA.

The Coalition of Safe Building Materials ("Coalition") respectfully requests that the Commission disapprove these proposed amendments or, in the alternative, require further study of the proposals prior to adoption. Substantial evidence exists that the approval of PEX and PEX-AL-PEX may result in significant health, safety

and environmental impacts. As a result, state law requires completion of environmental review under CEQA prior to adoption of these proposed regulations.

The Court of Appeal in the case *PPFA v. CBSC* recently affirmed that the Commission may not approve PEX without first complying with CEQA. To date, environmental review of PEX and PEX-AL-PEX has not even been initiated, much less completed. As a result, adoption of these proposed regulations would directly violate both the holding in *PPFA v. CBSC* and state law.

Furthermore, adoption of these regulations is not justified under the California Building Standards Law. The California Building Standards Law requires that building standards be justified in terms of the nine-point criteria listed in Health and Safety Code section 18930. Among these criteria are the requirements that adoption of the proposed standards be in the "public interest" and not be "unreasonable, arbitrary, unfair, or capricious." Because the safety and reliability of PEX and PEX-AL-PEX have not been sufficiently demonstrated or evaluated, approval of the proposed HCD amendments would not be in the public interest. Moreover, approval of PEX and PEX-AL-PEX would be unreasonable, unfair and contrary to the public interest since it would violate state law and the Court of Appeal's holding in *PPFA v. CBSC*.

B. The CBSC and DSA Proposals to Approve the Use of PEX-AL-PEX Should Be Disapproved or Tabled Pending Further Study

CBSC and the DSA have proposed the adoption of California building standards that would amend the current CPC to permit the use of PEX-AL-PEX (but not PEX) for potable water piping. (Monograph, supra, at pp. 3-132, 3-179.) The specific CBSC proposals that would approve the use of PEX-AL-PEX are

contained in the proposed amendments to CPC sections 604.1 and 604.13.[1] The DSA proposals that would approve the use of PEX-AL-PEX are contained in the proposed amendments to CPC sections 604.1 and 604.13, 604.13.1 and 604.13.2.

The Coalition respectfully requests that the Commission disapprove these proposed CBSC and DSA amendments or, in the alternative, require further study. Approval of PEX-AL-PEX would not be in the public interest because its safety and reliability has not been sufficiently demonstrated or evaluated. Furthermore, because there is evidence that approval of this product may result in a significant impact on the environment, approval is prohibited by state law prior to the completion of environmental review under CEQA. Again, CEQA review has not been started or completed for this proposed action. Accordingly, adoption of these regulations would violate state law and is not justified under the California Building Standards Law.

III. CURRENT PROCEDURAL POSTURE

PEX was first considered for adoption in the CPC in 2001 as a result of its inclusion as a new potable water material in the 2000 edition of the Uniform Plumbing Code ("UPC"). After receiving public comment, CBSC and each of the Proposing Agencies[2] determined that substantial evidence had been submitted indicating that approval of PEX may result in significant impacts. (*Plastic Pipe and Fittings Ass'n v. California Building Standards Com'n* ("*PPFA v. CBSC*") (2004)

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[1] The CBSC approves the use of PEX-AL-PEX in CPC section 604.1, but it fails to adopt CPC sections 604.13.1 and 604.13.2, which impose manufacturing, listing and installation requirements on the use of PEX-AL-PEX. While presumably an oversight, the CBSC's proposals would authorize the use of PEX-AL-PEX in CBSC regulated occupancies without the quality and performance standards contained in sections 604.13.1 and 604.13.2.

[2] The California Department of Housing and Community Development, the California Division of the State Architect-Structural Safety, the California Office of Statewide Health Planning and Development, the California Department of Health Services, and the California Department of Food and Agriculture (collectively, "the Proposing Agencies").

124 Cal.App.4th 1390.) As a result of the identification of these potential impacts, CBSC and the Proposing Agencies determined that further study was needed and denied approval. CBSC further ordered that environmental review of PEX proceed as required under CEQA. (*Id.*)

The Plastic Pipe and Fittings Association ("PPFA") then sued CBSC and each of the Proposing Agencies in the Los Angeles Superior Court, arguing that the failure to approve PEX was arbitrary and capricious, was not supported by substantial evidence and was contrary to law. (*Id.*) PPFA further argued that CEQA did not apply to the approval of building standards. (*Id.*)

The Superior Court granted PPFA's writ and ordered the approval of PEX. (*Id.*) CBSC and the Proposing Agencies appealed. (*Id.*) Numerous parties, including the members of the Coalition, joined the appeal as *amici curiae*. (*Id.*)

The Court of Appeal reversed the Superior Court's decision. The court held that the State's decision not to adopt the model code provision allowing the use of PEX pipe was not arbitrary, capricious or contrary to law and was supported by substantial evidence that approval could result in significant impacts. (*Id.*) The court further held that CEQA applies to the adoption of California building standards. (*Id.*)

The 2003 UPC again approves the use of PEX for potable water plumbing systems. In addition, the 2003 UPC approves, for the first time, another new potable water pipe referred to as PEX-AL-PEX. PEX-AL-PEX is a version of PEX that consists of an aluminum sheath covered by a layer of PEX on both its exterior and interior.

Despite the court's clear holding in the case *PPFA v. CBSC*, HCD now defiantly proposes the approval of PEX and PEX-AL-PEX without any compliance

with CEQA. Furthermore, DSA and CBSC propose the approval of PEX-AL-PEX without any compliance with CEQA. No initial study has been conducted and no EIR or negative declaration has been certified concerning these proposed actions. This failure to analyze the potential impacts of the approval of PEX and PEX-AL-PEX violates CEQA and is tantamount to contempt of the court's holding in *PPFA v. CBSC*.

IV. PREVIOUS ENVIRONMENTAL REVIEWS DEMONSTRATE THAT EXPANDED PLASTIC PIPE USE MAY CAUSE SIGNIFICANT IMPACTS ON PUBLIC AND WORKER HEALTH AND THE ENVIRONMENT

Over the past several decades, manufacturers and trade associations have proposed that different types of plastic pipe be approved by the State for use as plumbing material. Plastics vary widely in their chemical composition and, accordingly, have differing properties. Some plastics may be suitable for drinking water pipe, while others are suitable for use as drain or vent pipe. Some plastic materials have the potential to leach toxic chemicals into drinking water, some promote the growth of biofilms and dangerous pathogens, and others degrade quickly, causing plumbing systems to catastrophically rupture. The suitability of a plastic pipe for a proposed use can only be determined by examining its chemical components and by conducting appropriate tests and analyses.

In California, CEQA provides the mechanism to independently conduct such an evaluation of proposed plastic pipe products. Previous CEQA reviews of new plastic pipe products have served a vital function in California by revealing otherwise undisclosed problems and allowing the state to impose appropriate limitations and conditions on their use. As a result, California has been able to avoid the problems and damages from the unregulated use of these materials that have befallen other states without statutes similar to CEQA.

A. CEQA Review of CPVC Plastic Pipe Led to its Restricted Use

In the case of the plastic pipe product chlorinated polyvinyl chloride ("CPVC"), the environmental review process, although never fully completed, prompted manufacturers to reformulate the product to reduce public health impacts and led to restrictions on its use. CPVC was first proposed for statewide approval in California in 1982. The manufacturers of CPVC claimed that further study of their product's safety was unnecessary because it had already been approved for inclusion in the UPC and because it met the standards of NSF International, a private organization that tests and certifies products. HCD, nonetheless, determined that CEQA review was required.

The environmental review process initiated under CEQA disclosed that CPVC leached chloroform, a known human carcinogen, into the drinking water. The information disclosed in the environmental review process led the manufacturers to reformulate CPVC in an attempt to reduce or eliminate the use of chloroform as a swelling agent during manufacture. (Appendix ("A") 5 at 19.) Although the manufacturers claimed that the use of chloroform was not hazardous, they nonetheless engaged in a determined effort to reduce the levels of chloroform in the pipe.

The environmental review process also identified potentially significant air quality and worker health impacts associated with the solvents used to install CPVC. As a result, the state limited the circumstances under which CPVC could be used. (CPC § 604.1.2.) The state also imposed certain public and worker health mitigation measures on CPVC use. (*Id.*; CPC Appendix I, §§ 301.0.1.1 & 301.0.2.1.)

B. The Disaster of Polybutylene Plastic Pipe Was Largely Avoided in California (Only San Diego Suffered)

Polybutylene ("PB") pipe, which is similar in chemical makeup to PEX, was another plastic pipe product touted as safe and effective by its manufacturer, the Shell Chemical Company. The use of PB for carrying drinking water was first proposed for inclusion in the CPC in 1982, at the same time that CPVC was first proposed for inclusion. (See A-5 & A-6.) As with CPVC, HCD determined that environmental review of PB was necessary prior to approval in the CPC.

During the environmental review of PB, expert testimony showed that PB pipe included antioxidants, which were designed to prevent degradation of the plastic caused by oxidants. The evidence submitted in the environmental review process raised questions about the ability of these antioxidants to protect the PB pipe and indicated that the pipe could be degraded by chlorine and oxygen, causing loss of strength, brittleness, and ultimately, premature mechanical failure. (See A-5 at 34.) Studies were also conducted showing that PB may leach toxic chemicals into drinking water. (*Leonardini v. Shell Oil Co.* (1989) 216 Cal.App. 3d 547, 557.)

Shell vehemently disputed this testimony and claimed in written submittals to HCD that PB had a performance life of fifty years. Shell attacked members of the public (including Coalition member, the California Pipe Trades Council, and its then attorney, Raymond Leonardini) for suggesting that PB could leach toxic chemicals into drinking water. Shell went so far as to sue Leonardini for trade libel, based on these criticisms of PB. (*Id.*)

Although the Department persisted in requiring environmental review of PB before authorizing its use statewide, San Diego, unfortunately, took local action to approve PB for use in that city. While the state's environmental review was proceeding, PB began to degrade and to fail spectacularly all across the United

States, drenching homes with water, including homes in San Diego, and causing enormous damage. (A-5 at 31-32; see also A-7.)

Because of the dramatic and extensive problems with PB, California never approved it for use statewide, and the UPC withdrew its approval of PB. Shell was sued across the nation, as well as in San Diego, where class-action lawsuits were filed on behalf of 60,000 homeowners with failing PB pipe. (See A-7.) Shell withdrew the product from the marketplace and stopped all manufacture of the pipe. It is estimated that more than one million American homes may eventually suffer problems with PB failures. (*Id.*)

Shell ultimately agreed to a one billion dollar settlement of the claims. (*Id.*) Further, Leonardini won a spectacular five million dollar judgment against Shell for malicious prosecution of the trade libel claim. (*Leonardini v. Shell Oil Co., supra,* 216 Cal.App. 3d at p. 555.)

The Department's action in requiring CEQA review of PB, despite enormous pressure from Shell, saved Californian homeowners from millions of dollars of potential damages from unsuitable plastic pipe water lines.

C. CEQA Review Has Revealed Problems With Other Plastics

Other plastic materials, such as acrylonitrile butadiene styrene ("ABS") and polyvinyl chloride ("PVC") have been proposed for various plumbing uses, including use as drain, waste and vent pipe. (See A-5.) As with CPVC and PB, CEQA review of these materials was required. (Id. at p. 36.)

The ABS manufacturers argued that CEQA review was unnecessary and asserted that NSF certification and inclusion in the model code proved that the material was sound. By 1990, however, the decision to require CEQA review of

ABS plastic pipe was proven prudent when numerous buildings that had been permitted to use ABS experienced extensive failures leading to numerous consumer lawsuits and class action claims for damages. As a result, the state took action to restrict the use of ABS. (Health & Saf. Code § 17921.7.)

D. The State's Conservative and Deliberate Course Has Saved Californians From the Damages Suffered in Other Jurisdictions

The past environmental review of new plastic pipe products in California has saved this state from the problems and damages that unregulated use of plastic pipe materials has caused in other jurisdictions. Such review has revealed previously unexamined or undisclosed hazards and has resulted in changes in manufacturing practices and the imposition of mitigation measures to reduce impacts on the public and on workers. This conservative and deliberate course of environmental review should again be followed prior to approving PEX or PEX-AL-PEX.

V. CEQA APPLIES TO THE PROPOSED APPROVAL OF PEX AND PEX-AL-PEX

A. Overview of CEQA

CEQA compliance prior to the proposed approval of PEX and PEX-AL-PEX plastic pipe is not only prudent, but is legally required. The purpose of CEQA is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. (Pub. Resources Code §§ 21063 & 21100.) Thus, CEQA "protects not only the environment but also informed self-government." (*Communities for a Better Environment v. Calif. Resources Agency* (2002) 103 Cal. App. 4th 98, 108.) The Supreme Court has held that CEQA is "to be interpreted ... to afford the fullest possible protection to the environment within the reasonable scope of the statutory language." (*Laurel Heights Improvement Assoc. v. Regents of*

Univ. of Calif (1988) 47 Cal.3d 376, 390; *Communities for a Better Environment v. Calif. Resources Agency, supra,* 103 Cal. App. 4th at p. 110.)

B. CEQA Applies to the Adoption of the Proposed Building Standards

An agency action is subject to CEQA if it: (1) is a discretionary action undertaken by a public agency, and (2) may cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment. (Pub. Resources Code §§ 21065, 21080; Cal. Codes Regs., tit. 14 ("CEQA Guidelines") §§ 15061, 15357, 15358, 15378.) In the recent *PPFA v. CBSC* case, the court conclusively established that the proposed adoption of building standards allowing the use of PEX and PEX-AL-PEX is a discretionary action that may cause a reasonably foreseeable indirect physical change in the environment and thus is subject to CEQA. This holding is binding on the Commission and the Proposing Agencies both as published case law and under the doctrine of collateral estoppel.

1. Adoption of the Proposed Building Standards Is a Discretionary Action

The adoption of regulations is considered "discretionary" under CEQA if any application of judgment is required. (*PPFA v. CBSC, supra,* 124 Cal.App.4th 1390; see also *Wildlife Alive v. Chickering* (1976) 18 Cal.3d 190, 206 (holding that CEQA applies to the enactment of regulations).) The courts have uniformly held that the adoption of building standards meets this definition and is subject to environmental review under CEQA. For example, the court in the case *Building Code Action v. Energy Resources Conservation and Development Commission,* (1980) 102 Cal.App.3d 577, held that adoption of energy conservation regulations establishing double-glazing standards for new residential construction was subject to CEQA since it could result in a significant impact on air quality as a result of increased glass production.

Likewise, in the 1997 *Cuffe* case, the San Francisco Superior Court held that the adoption of building standards that would approve CPVC plastic drinking water pipe was subject to CEQA. (*Cuffe v. California Building Standards Commission* (1997) San Francisco Superior Court No. 977657 (Wm. Cahill, J.).) In *Cuffe*, the Court granted a writ of mandate compelling CBSC and HCD to conduct CEQA review prior to deciding whether to approve the use of CPVC. (*Id.*) The court found that the approval of CPVC may result in significant impacts on the environment because of the "possibility of chemical leaching and solvents polluting drinking water," as well as "potential chemical exposure to workers installing the pipe." (*Id.*) The court held that environmental review under CEQA was required to examine these potential impacts. (*Id.*)

More recently, in the *PPFA v. CBSC* case, the California Court of Appeal affirmed the application of CEQA to building standard regulations as it applies directly to PEX. (*PPFA v. CBSC*, *supra*, 124 Cal.App.4th 1390.) The court held that the approval of new building standards is a discretionary act and that no statutory or categorical exemptions from CEQA apply to the promulgation of building standards. (*Id.* at 1413.) Accordingly, it is now firmly established that the adoption of building standards allowing the use of PEX and PEX-AL-PEX is a discretionary action under CEQA.

2. Adoption of the Proposed Building Standards May Cause a Reasonably Foreseeable Indirect Physical Change in the Environment

A discretionary action is subject to CEQA if it may cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment. (Pub. Resources Code § 21065.) Because an activity need not cause an immediate change to the environment to be considered a project, the courts have widely held that the issuance of regulations may result in reasonably

foreseeable indirect physical changes in the environment. (*PPFA v. CBSC, supra,* 124 Cal.App.4th at 1412-1413; *Wildlife Alive v. Chickering, supra,* 18 Cal.3d at 206.)

In reviewing whether a government action may cause a physical change in the environment, the "fair argument standard" is applied. (*Dunn-Edwards v. Bay Area Air Quality Management District ("BAAQMD")* (1992) 9 Cal.App.4th 644, 654-656; *Castaic Lake Water Agency v. City of Santa Clarita* (1995) 41 Cal.App.4th 1257, 1264-1265.) Under this standard, CEQA review occurs "whenever it can be fairly argued on the basis of substantial evidence" that the project may cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment. (*Dunn-Edwards v. BAAQMD, supra,* 9 Cal.App.4th at p. 655.)

"'Substantial evidence' . . . means enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached." (*Castaic Lake Water Agency v. City of Santa Clarita, supra,* 41 Cal.App.4th at pp. 1264-1265.) The CEQA Guidelines define substantial evidence as including "facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts." (CEQA Guidelines, § 15064(f)(5).) As a matter of law, "substantial evidence include . . . expert opinion." (Pub. Res. Code § 21080(e)(1); CEQA Guidelines § 15064(f)(5).)

The substantial evidence required to make the initial determination to apply CEQA is, necessarily, minimal. (*See Simi Valley Recreation and Park District v. Local Agency Formation Commission* (1975) 51 Cal.App.3d 648, 663; *Davidon Homes v. City of San Jose* (1997) 54 Cal.App.4th 106, 118.) A reviewing court's decision as to whether an activity is a "project" need only be based on the most preliminary of investigations, rather than based on an initial study or other environmental document. As one court observed, "[t]he existence of a project cannot depend on the outcome of the inquiry which the act contemplates only after the existence of a project is established." (*Simi*

Valley Recreation and Park District v. Local Agency Formation Commission, supra, 51 Cal.App.3d at p 663.)

In the case at hand, substantial evidence that the approval of PEX and PEX-AL-PEX pipe may result in reasonably foreseeable indirect physical changes in the environment is presented herein and in the attached expert comments and appendices. This evidence is discussed in detail, *supra*, in section VI of this letter. Because the fair argument standard applies, this evidence conclusively establishes that CEQA applies regardless if other contrary evidence is presented.

3. Under the Doctrine of Collateral Estoppel, the Commission and the Proposing Agencies Are Bound by the Court's Determination in *PPFA v. CBSC* That Approval of PEX May Result in a Physical Change in the Environment

Moreover, because the court in *PPFA v. CBSC* expressly concluded that approval of PEX may have a reasonably foreseeable indirect environmental impact requiring compliance with CEQA, the Commission and the Proposing Agencies are prohibited under the doctrine of collateral estoppel from now concluding that CEQA does not apply. (*PPFA v. CBSC, supra,* 124 Cal.App.4th at pp. 1412-1413.) In *PPFA v. CBSC*, the court held that substantial evidence, in the form of a July 23, 2001 expert comment letter submitted by Thomas Reid, had been submitted demonstrating that the use of PEX may result in leaching, permeation, premature failure or fire safety impacts. (*PPFA v. CBSC, supra,* 124 Cal.App.4th at pp. 1413, 1416.) As parties to the *PPFA v. CBSC* proceedings, the Commission and the Proposing Agencies are collaterally estopped from now concluding that Mr. Reid's same opinion, resubmitted here as Exhibit D and updated and restated in new comments submitted here as Exhibit A, does not constitute substantial evidence that approval of PEX may result in a "reasonably foreseeable indirect physical change in the environment."

The doctrine of collateral estoppel "precludes a party to an action from relitigating in a second proceeding matters litigated and determined in a prior proceeding." (*People v. Sims* (1982) 32 Cal.3d 468, 477.) This doctrine serves the purpose of conserving judicial resources, protecting persons from vexatious litigation, and avoiding the possibility of conflicting results. (*Bernhard v. Bank of America Nat. Trust & Savings* (1942) 19 Cal.2d 807, 811.) In the case at hand, the doctrine prohibits the relitigation of the issue of whether Mr. Reid's opinion constitutes substantial evidence that approval of PEX may result in a reasonably foreseeable indirect physical change in the environment.

The doctrine of collateral estoppel applies where certain threshold requirements are fulfilled. First, the issue sought to be precluded from relitigation must be identical to that decided in a former proceeding. Second, this issue must have been actually litigated in the former proceeding. Third, it must have been necessarily decided in the former proceeding. Fourth, the decision in the former proceeding must be final and on the merits. Finally, the party against whom preclusion is sought must be the same as, or in privity with, the party to the former proceeding. (*Gikas v. Zolin* (1993) 6 Cal.4th 841, 849.)

Here, the requirements for application of the doctrine of collateral estoppel have been met. In *PPFA v. CBSC,* the parties expressly litigated the issues of whether CEQA applied and whether Mr. Reid's expert comments constituted substantial evidence. (*PPFA v. CBSC, supra,* 124 Cal.App.4th at pp. 1407-1408.) The court reviewed the record and concluded that Mr. Reid's comments were, in fact, substantial evidence that the use of PEX may result in reasonably foreseeable indirect physical changes in the environment due to leaching, permeation, mechanical failure and increased fire hazards. (*Id.*) The *PPFA v. CBSC* case resulted in a judgment on the merits and the Commission and HCD were both parties to the case. Thus, the Commission and HCD are precluded from now

reversing the position on which they prevailed and arguing that Mr. Reid's opinion does not constitute substantial evidence.

The Court of Appeal's evidentiary finding in *PPFA v. CBSC* remains valid even though HCD now asserts that it has investigated Mr. Reid's claims and has found "no basis" for excluding PEX. (Monograph at 3-243.) A fair argument exists if there is *any* substantial evidence in the record that a project may cause a physical change in the environment, *even if other substantial evidence supports the opposite conclusion.* (*Dunn-Edwards v. BAAQMD, supra,* 9 Cal.App.4th at pp. 654-656; *Castaic Lake Water Agency v. City of Santa Clarita, supra,* 41 Cal.App.4th at pp. 1264-1265.)

In the case at hand, the *PPFA v. CBSC* court has already held that such substantial evidence exists. The Commission and the Proposing Agencies are bound by this ruling. Accordingly, compliance with CEQA is required as a matter of law, regardless of the conclusion of HCD's internal investigation.

C. An EIR Must Be Prepared Prior to the Adoption of the Proposed Building Standards

Both the evidence before the court in the *PPFA v. CBSC* case and the updated, new evidence presented herein is more than enough to meet the minimal standard of evidence required to trigger the requirement to comply with CEQA. Moreover, this same evidence establishes a fair argument that the approval of PEX and PEX-AL-PEX may result in significant environmental impacts and thus requires the preparation of an EIR.

If an action is subject to CEQA, then an initial study must be prepared to determine the next required step. (CEQA Guidelines § 15063.) An initial study is a

preliminary analysis used to determine whether an EIR or negative declaration must be prepared. (CEQA Guidelines §§ 15063, 15365.)

The courts have repeatedly recognized that the EIR is the "heart of CEQA." (*The Pocket Protectors v. City of Sacramento* (2004) 124 Cal.App.4th 903, 926.) CEQA requires that a public agency prepare an EIR on any activity it undertakes or approves which may have a significant impact on the environment. The EIR aids an agency in identifying, analyzing, disclosing, and, to the extent possible, avoiding a project's significant environmental effects through implementing feasible mitigation measures. (Pub. Resources Code § 21002.1, subd. (a); CEQA Guidelines § 15002, subd. (a), (f).) The EIR thus acts as an "environmental 'alarm bell' whose purpose is to alert the public and its responsible officials to environmental changes before they have reached the ecological points of no return." (*Bakersfield Citizens for Local Control v. City of Bakersfield* (2004) 124 Cal.App.4th 1184, 1220.)

In certain limited circumstances, a negative declaration may be prepared instead of an EIR. A negative declaration is permitted when, based upon the initial study, a lead agency determines that a project "would not have a significant effect on the environment." (*Id.*; Pub. Resources Code § 21080, subd. (c).) However, such a determination may be made only if "[t]here is no substantial evidence in light of the whole record before the lead agency" that such an impact may occur. (*Id.*)

When determining if an EIR must be prepared, the fair argument standard applies. The fair argument standard is a "low threshold" test for requiring the preparation of an EIR. (*The Pocket Protectors v. City of Sacramento, supra,* 124 Cal.App.4th at p. 928.) A public agency must prepare an EIR whenever substantial evidence supports a fair argument that a proposed project "may have a significant effect on the environment." (*Id.* at p. 927; Pub. Resources Code §§ 21100, 21151, 21080.) Significant effect on the environment "means a substantial, or potentially

substantial, adverse change in the environment." (Pub. Resources Code § 21068; *The Pocket Protectors v. City of Sacramento, supra,* 124 Cal.App.4th at p. 927.)

If the record contains substantial evidence supporting a fair argument that a project may have a significant effect on the environment, the lead agency shall prepare an EIR, even though it may also be presented with other contrary evidence that the project will not have a significant effect. (Pub. Resources Code § 21151, subd. (a); *The Pocket Protectors v. City of Sacramento, supra,* 124 Cal.App.4th at p. 927.) CEQA places the burden of environmental investigation on government agencies and project proponents rather than the public. (*Id.*) As a result, an agency is not "allowed to hide behind its own failure to gather relevant data." (*Gentry v. City of Murietta* (1995) 36 Cal.App.4th 1359, 1378-1379, citing *Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296, 311.) "If the lead agency has failed to study an area of possible environmental impact, a fair argument may be based on the limited facts in the record. Deficiencies in the record may actually enlarge the scope of fair argument by lending a logical plausibility to a wider range of inferences." (*Id.*)

In the case at hand, the record contains extensive evidence, including the attached expert comments and appendices, that establish that the approval of PEX and PEX-AL-PEX pipe may have a significant impact on the environment. Accordingly, preparation of an EIR is required prior to approval of these products.

VI. SUBSTANTIAL EVIDENCE ESTABLISHES A FAIR ARGUMENT THAT THE APPROVAL OF PEX AND PEX-AL-PEX MAY RESULT IN SIGNIFICANT ENVIRONMENTAL IMPACTS AND THUS REQUIRES THE PREPARATION OF AN EIR

The evidentiary findings made in *PPFA v. CBSC* are based upon the preliminary July 23, 2001 comments submitted by Thomas Reid. Since the submittal of those comments, substantial new evidence of the potential

environmental impacts of approving PEX and PEX-AL-PEX has been uncovered. This new evidence both substantiates and expands upon the concerns raised by Mr. Reid in his 2001 comments

The evidence presented herein includes substantial evidence that:

- Chemicals such as Methyl-tert-Butyl ether ("MTBE"), tert-Butyl alcohol ("TBA") and various benzene-type aromatic hydrocarbons may leach directly out of PEX Pipe and PEX-AL-PEX Pipe and contaminate drinking water at levels that exceed California standards;

- Pesticides, termiticides, benzene, gasoline constituents and other toxic chemicals may permeate PEX pipe and enter drinking water;

- PEX and PEX-AL-PEX pipe may degrade prematurely and rupture due to exposure to numerous commonly encountered materials and environmental conditions;

- PEX and PEX-AL-PEX pipe may promote the growth of biofilms containing dangerous microbes such as Legionella;

- PEX and PEX-AL-PEX pipe may not be recyclable and thus present solid waste disposal issues; and

- PEX and PEX-AL-PEX pipe may pose a fire hazard.

Evidence of these potential impacts includes the updated and expanded comments of Mr. Reid. Mr. Reid, president of Thomas Reid Associates, is eminently qualified to review and comment on the potential environmental impacts of plastic pipe. Mr. Reid received his training in chemical engineering at Yale University and his training in biological sciences at Stanford. He has prepared environmental studies for almost thirty years and he has studied the chemistry and the associated environmental impacts of plastic plumbing for over twenty years. He also has over twenty years of experience providing expert testimony to agencies on building materials and building standards issues. Mr. Reid's curriculum vitae is attached as Appendix 2.

Mr. Reid's expertise on plastic plumbing pipe materials has been recognized by California courts for more than a decade. (See *ABS Institute v. City of Lancaster* (1994) 24 Cal.App.4th 285.) Most recently, the Court of Appeal in the *PPFA v. CBSC* case recognized Mr. Reid as a qualified expert on the potential dangers of PEX Pipe, including the potential for chemical leaching, permeation, mechanical failure and fire hazards. (*PPFA v. CBSC, supra,* 124 Cal.App.4th at p. 1407.) The court held that "there is no reasonable question that Mr. Reid is qualified to state his opinion on these subjects." (*Id.*) Mr. Reid's updated comment letter is attached as Exhibit A. Mr. Reid's letter is incorporated by reference and hereby made a part of the Coalition's comments.

Evidence of these potential impacts also includes the expert comments of Dr. Robert Clark. Dr. Clark is a principal and founding member of GT Engineering. Dr. Clark holds a bachelors of science degree in metallurgy, a masters of science degree in materials science and engineering, and a Ph.D. in materials science and engineering with a metallurgy specialization and a minor in mechanical engineering, all from the University of California at Berkeley. His specialty is the investigation and determination of cause for degradation and failure in materials. This has included extensive work involving failures in engineered plastic or polymeric products such as molded parts, tubing, woven products and cordage (PVC, CPVC, polypropylene ("PP"), PE, PEX, ABS, EPDM, nylon etc.). Dr. Clark has testified in cases across the United States as a court qualified expert in materials science, mechanical engineering, metallurgy, corrosion and accident reconstruction. Most recently, Dr. Clark has served as an expert consultant and investigator for numerous litigation cases involving PEX piping failures in Washington State. Dr. Clark's curriculum vitae is attached as Appendix 3.

Dr. Clark submits two comment letters attached hereto as Exhibits B and C. The first comment letter addresses the propensity of PEX piping to prematurely degrade and rupture. The second comment letter addresses the propensity of PEX

and PEX-AL-PEX piping to promote the growth of biofilm containing dangerous microbes including Legionella. Dr. Clark's comment letters are incorporated by reference and hereby made a part of the comments of the Coalition.

These comments also reference a number of additional supporting technical documents, reports and other evidence that are attached hereto as exhibits. These supporting exhibits are also incorporated by reference and hereby made a part of the comments of the Coalition.

A. Adequate Examination of the Potential Impacts of PEX Requires Analysis of the Different Classes of PEX and the Various Additives and Recipes for Making PEX

PEX and PEX-AL-PEX are generic terms for pipe that is made with cross-linked polyethylene. (Exhibit A.) Crosslinking is a delicate operation. Either too much of it or too little of it can compromise the quality of the finished product. (Exhibits D & F; Appendix 9.) There are currently three commercial methods of cross-linking:

- PEX-A, the so-called Engel method, where the polyethylene resin and a chemical additive are heated to produce cross-linking;
- PEX-B, the silane method which produces silicon-oxygen cross-link bonds; and
- PEX-C, where cross-linking is initiated by gamma or electron beam radiation.

The different manufacturing processes produce slightly different products with different chemical and mechanical characteristics. (Exhibits A -G.) Because the proposed regulations approving PEX do not differentiate between the classes of PEX, environmental review under CEQA must include evaluation of the potential impacts of all three types of PEX.

Furthermore, even within these three different classes, manufacturers use varying different chemical additives, stabilizers and recipes. (*Id.*) Accordingly, quality of the metals varies widely from manufacturer to manufacturer and from resin batch to resin batch. (*Id.*) Information on all of these additives, as well as the underlying manufacturing process and chemicals used, must be disclosed if the potential impacts of PEX are to be appraised.

B. Substantial Evidence Exists That Chemicals Such as MTBE and T- Butanol Leach Directly From PEX Pipe and PEX-AL-PEX Pipe and May Contaminate Drinking Water

In his attached comments, Mr. Reid determines that substantial evidence exists that chemicals such as MTBE and TBA may leach out of PEX and PEX-AL-PEX pipe, potentially contaminating drinking water in levels that greatly exceed California standards for health, odor and taste. Several recent studies corroborate that leaching from PEX and PEX-AL-PEX may pose a problem. Moreover, leaching appears to have contributed to the contamination of drinking water in a lawsuit in Arizona. The California Office of Statewide Health Planning and Development ("OSHPD") has also concluded that PEX "does have chemical leaching problems." (Monograph at p. 3-158.)

In the Arizona lawsuit, Uponor Wirsbo ("Wirsbo"), a major PEX manufacturer, was sued for its product's alleged contamination of drinking water with MTBE, TBA and benzene. (A-10 & A-11.) Wirsbo is the manufacturer of AQUAPEX and is one of the largest North American PEX distributors. AQUAPEX is made from PEX-A, cross-linked polyethylene manufactured through the Engle method. The Engle method involves extruding the pipe resin with a peroxide catalyst and other additives. (Exhibit A.)

According to her complaint, plaintiff Joyce Defren purchased a house from Trimark Homes in Scottsdale, Arizona. The house was plumbed with AQUAPEX. Ms. Defren found the water to have a bad taste causing her to become concerned that her water was contaminated. When a lab tested the water, it was found to contain several organic chemicals, including MTBE, TBA, and various benzene-type aromatic hydrocarbons.

During this litigation, Wirsbo disclosed that MTBE and TBA are by-products of the manufacturing process that may have leached from the PEX pipe into drinking water. (A-12 at 3.) Laboratory tests released by NSF International also confirmed that PEX may leach significant amounts of MTBE. The NSF tests found MTBE in potable water flushed through PEX piping in concentrations of 15, 17 and 22 parts per billion. (Exhibits A & F; A-13.) This exceeds both California's taste and odor threshold for MTBE of 5 parts per billion and California's health-based Maximum Contaminant Level ("MCL") for MTBE of 13 ppb. (Exhibit A; A-15, A-16 & A-17.)

Tests have also revealed significant leaching of TBA from PEX pipe. The leaching tests released by NSF International revealed normalized concentrations of TBA ranging up to 6900 ppb. (A-13.) These concentrations appear to increase dramatically where water is allowed to sit in PEX pipe for several months. For example, Dr. Michael Fox, a former consultant to Wirsbo, states on his website that his testing found TBA in concentrations of 10,000 ppb and greater in drinking water that had been sitting stagnant in a house plumbed with PEX tubing. (A-14.)

Further evidence of PEX's leaching risk is found in OSHPD's review of the proposed approval of PEX. (Monograph at 3-158.) OSHPD has building standards jurisdiction over hospitals, health clinics, nursing homes, acute care and other health care facilities. (Health & Saf. Code §§ 1275, 1276.) These facilities contain populations of sensitive receptors (the elderly, the infirm and other persons with

weakened or impaired immune systems) who might be especially vulnerable to any toxics leaching from PEX piping.

OSHPD finds in its Initial Statement of Reasons that "[s]tudies have demonstrated that PEX material is susceptible to chemical leaching." (Monograph at 3-158.) OSHPD states that PEX may leach MTBE and TBA as by-products of the manufacturing process. (*Id.*) OSHPD concludes that additional research and study must be performed to demonstrate the safety and reliability of PEX and PEX-AL-PEX.

Recent reports on leaching tests in Norway have also found high leaching levels of volatile organic components ("VOCs") migrating into drinking water resulting in significant taste and odor issues and possible health risk.[3] (A-18 & A-19.) Most of the VOCs were not identified, but the report did identify MTBE as one of the leachates. MTBE was found in concentrations as high as 47.6 ppb, almost four times the level allowed under California's health-based MCL. (A-19.)

Leaching of MTBE and TBA may cause both significant taste and odor impacts on drinking water and cause significant health risks. The Norwegian studies found that VOCs leaching from PEX pipes gave an "intense" unwanted odor to the test water. (A-18 & A-19.)

Even minute amounts of MTBE are known to give water an offensive taste similar to paint thinner and an offensive odor similar to turpentine. (A-15.) As a result, the California Department of Health Services ("DHS") has set a taste and odor threshold for MTBE of 5 parts per billion. (A-16.) The exceedance of this

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[3] The report also concluded that the high leaching levels of organic compounds from PEX pipes used at in-door temperatures may promote bacterial regrowth. The report recommended further study of this potential impact. See *infra*, Section IV (E).

threshold resulting in the contamination of drinking water with offensive taste and odor is a significant impact requiring the preparation of an EIR.

In addition to taste and odor impacts, the leaching of MTBE into PEX may have adverse effects on human health. The University of California has concluded that MTBE is an animal carcinogen with the potential to cause cancer in humans. (A-15, A-50.) The U.S. EPA has also stated the MTBE has the potential to cause cancer in humans. (Exhibit A; A-15 & A-51.) OSHPD states in its review of PEX that MTBE is a "known human carcinogen." (Monograph at 3-158.) Studies on animals suggest that MTBE has the potential to cause developmental toxicity. (A-44, A-50 & A-51.) As a result of these health concerns, DHS has set a health-based Maximum Contaminant Level ("MCL") on MTBE of 13 ppb. (A-16 & A-51; See Health & Saf. Code §§ 116365, 116610) The California Office of Environmental Health Hazard Assessment ("OEHHA") has also adopted a public health goal ("PHG") for MTBE of 13 ppb for drinking water. (A-17 & A-21.)

The leaching of TBA may also have adverse affects on human health. Studies have found evidence of a carcinogenic response to TBA. (A-22 & A-50.) As a result, DHS has adopted an action level on TBA of 12 ppb. (*Id.*; see also Health & Saf. Code § 116445; A-14.)

PEX-AL-PEX also suffers from the same potential chemical leaching problem. PEX-AL-PEX has an aluminum middle covered by PEX on both the outside and the inside. The interior of PEX-AL-PEX, which is in contact with the drinking water, is identical to that of regular PEX piping and will likely experience the identical problems with leaching. (Exhibit A at 11; see also Monograph at p. 3-158 (OSHPD concludes that "there is no reason to believe that [the layer of aluminum in PEX-AL-PEX] will have any effect on the leaching from the material itself.").)

Because of the tendency of PEX and PEX-AL-PEX pipe to leach, Mr. Reid concludes that all breakdown products from antioxidants and other substances that may be formed in the pipe by reaction with chlorine in the water supply need to be assessed to determine if they would contaminate the water carried by PEX and PEX-AL-PEX pipe. (Exhibits A, D-G.) To date, however, PEX and PEX-AL-PEX manufacturers have not disclosed to the state agencies sufficient information to allow for a meaningful assessment of the leaching characteristics and potential hazards of their product.

Mr. Reid concludes that PEX and PEX-AL-PEX certification under the ANSI/NSF Standard 61 (a basic public health standard set by NSF International, a private standard-setting organization) is not an adequate substitute for such disclosure. Nor does NSF certification refute the chemical leaching potential of PEX and PEX-AL-PEX. (*Id.*) For example, NSF/ANSI certification permits leaching of MTBE at a level of 50 ppb. (A-23, A-24.) This is ten times the California threshold for offensive taste and odor and almost four times the health-based MCL set by the California Department of Health Services. (A-16.) Moreover, as explained by Mr. Reid, the NSF/ANSI tests use techniques and assumptions that may allow for certification of PEX that, in real life use, significantly exceed this 50 ppb level. (Exhibits A, D-G.) NSF/ANSI certification simply fails to ensure that PEX will not leach chemicals in an amount that will not potentially impact taste, odor or human health.

The potential cumulative impacts of PEX and PEX-AL-PEX leachates must also be assessed. Even low levels of MTBE leaching from PEX may have a significant effect when combined with the levels already found in drinking water. Due to the brief, but disastrous experiment of using MTBE as a gasoline additive, MTBE contamination of drinking water is a problem of statewide magnitude. DHS has identified 109 public drinking water systems with consistent MTBE drinking water detections. (Exhibit A; A-25 & A-51.) Twenty-eight percent (28%)of these

systems were contaminated at levels above the health-based PHG and primary MCL of 13 ppb, while fifty-three percent (53%)were contaminated at levels above the secondary MCL for taste and odor. (*Id.*)

For those systems contaminated at levels just under the primary MCL, PEX pipe would need to contribute only 1 to 8 ppb of MTBE to bring the water from the taste and odor threshold to the health threshold. (*Id.*) MTBE may also permeate through PEX pipe where the pipe is exposed to contaminated water or soil, further adding to the cumulative impact. (*Id.*) Further evaluation of this issue is necessary to determine if PEX should be barred in areas that may potentially be contaminated with MTBE.

There is substantial evidence that PEX and PEX-AL-PEX may leach MTBE and TBA in amounts that exceed California drinking water standards for health, taste and odor. The public health guidelines, MCLs and action levels applicable to MTBE and TBA represent the state's considered efforts to protect consumers. HCD's cavalier disregard for these protective guidelines is inexcusable. The proposed approval of PEX and PEX-AL-PEX would allow the deliberate installation of products that exceed levels the state has set to protect health or to protect the taste and odor of drinking water. Accordingly, the leaching of MTBE and TBA are significant impacts that must be evaluated in an EIR.

C. Substantial Evidence Exists That Numerous Commonly Encountered Construction Materials and Soil Contaminants May Permeate PEX Pipe and Contaminate Drinking Water

PEX is subject to permeation by a number of commonly encountered construction materials and soil contaminants. (Exhibits A–G; A-27– A-32.) As currently proposed, the approval of PEX would allow the installation of PEX for external use from the water meter to the building structure and for use under the slab. (Monograph at 3-207.) As a result, permeation is a particular concern where

the soil or groundwater is contaminated with oil, gasoline or other petroleum products. Certain pesticides and termiticides may also pose a significant risk.

Permeation of PEX due to contaminated soils was one of the issues raised during the Arizona litigation discussed above. The PEX manufacturer, Wirsbo, stated that benzene was in the plaintiff's drinking water due to the termiticide in the soil surrounding the buried pipe, thus inferentially admitting that the benzene in the termiticide permeated the pipe. (A-12.) Wirsbo claimed that is was not at fault for such permeation because it warns against exposing pipe to potentially permeating compounds: "The permeable characteristics of cross-linked polyethylene tubing prohibit installation in soil or ground water contaminated with solvents, fuels, organic compounds or other detrimental materials." (A-12.)

As explained in Mr. Reid's attached comments, such pollutants may contain low molecular weight substances, such as benzenes and MTBE that readily migrate through the seemingly solid polymer barrier of PEX, contaminating the water inside the pipes. (Exhibit A.) Mr. Reid calculates that a PEX tube exposed to a 0.2% benzene concentration in a termiticide or in gasoline, would produce benzene in drinking water at around 10 ppb after standing overnight and upwards of 100 ppb after standing for a week. (*Id.*) This result is in line with the laboratory tests from the Arizona litigation which found alkyl substituted benzenes at roughly 70 to 220 ppb. Mr. Reid concludes that PEX in contaminated ground may easily exceed the state MCL of 1 ppb.

Because of this risk, the Plastics Pipe Institute warns that thermoplastic pipes should not be used where they may come in contact with permeating chemicals:

"In general, chemicals that affect plastics do so in one of two ways. One effect is chemical solubility or permeation. The other is direct chemical attack. In

the case of solubility or permeation, physical properties may be affected, but the polymer molecule structure itself is not chemically changed, degraded or destroyed. In solubility or permeation, gas, vapor, or liquid molecules pass through the polymer, typically without damaging the plastic material itself.

* * *

Permeation may do little if any harm to the material, but it may have application-related effects. The permeating chemical may transfer into a fluid on the other side of the pipe. In general, thermoplastic pipes should not be used where a permeating chemical could compromise the purity of a fluid such as potable water inside the pipe . . . ."
(A-32.)

The PEX industry acknowledges that PEX is susceptible to permeation and warns consumers not to allow PEX to come in extended contact with numerous commonly encountered construction materials. One installation handbook warns installers as follows:

"Do not allow tubing to come in extended contact with any of at least the commonly encountered construction materials listed below: (This list is not all-inclusive.) Pipe thread sealing compounds; Fire wall penetration sealing compounds. Exception: water soluble, gypsum-based caulking; Petroleum-based materials such as: Kerosene Benzene Gasoline, Solvents, Fuel Oils, Cutting Oils, Asphaltic Paint, and Asphaltic Road Materials."
(A-29.)

As can be seen from the breadth of this warning, it would be difficult for PEX pipe not to come into contact with at least some of these materials. Furthermore, this warning is admittedly not comprehensive.

The PEX industry also warns not to place any PEX tubing in "heavily contaminated soils or other heavily contaminated environments." (*Id.*) This warning, however, is vague and fails to define for the consumer when soils should be considered "heavily contaminated." Further information is needed to reveal how contaminant-free soil must be to ensure the safe use of PEX.

The type of PEX at issue in the Arizona litigation was PEX-A. As discussed above, there are at least three commercial classes of PEX: PEX-A, PEX-B and PEX-C. Each class would be expected to have different leaching and permeation behavior because of the different methods used to cause cross-linking. (Exhibits A-G.) The proposed amendment to the California Building Standards Code does not distinguish between these different classes of PEX and would allow any of them to be used in California. As a result, an adequate evaluation of the permeation impacts of PEX must examine the different types of PEX.

Any examination of permeation impacts must also consider both short-term and long-term effects. A recent study by Gastec Technology BV in the Netherlands suggests that the rate of permeation of PEX by certain chemicals such as Tetrahydrothiophene ("THT") may accelerate by as much as four hundred percent (400%) after one month of exposure. (A-31) This study demonstrates that short-term tests alone may fail to reveal the full scope of PEX's potential permeation impacts.

OSHPD, in disagreement with HCD, has determined that PEX's permeation susceptibility to so many commonly encountered construction materials creates a significant risk of adverse impacts requiring further review. (Monograph at 3-158.) OSHPD observes that there is an enormous variety of construction materials used on a project and that materials may be changed from what is approved on the drawings. (*Id.*) OSHPD concludes that requiring contractors and workers to know

the chemical composition of all the materials and adverse interactions with chemicals found in other materials is "not a reasonable expectation." (*Id.*)

As OSHPD recognizes, requiring consumers to themselves identify every possible permeation risk is not a reasonable mitigation. In the Arizona litigation, Wirsbo claimed that where such contaminated conditions are suspected, chemical analysis of the soil or ground water should be performed before installation." This is also not a realistic requirement. Furthermore, even if California imposed a soil-testing requirement, this would not address the risk from contamination that occurs after the pipe is installed.

PEX manufacturers admit that permeation of PEX can be a serious problem, but their approach to addressing this issue is to disclaim any liability. Such an approach does not protect the consumer. An EIR is needed to consider the full scope of the permeation risk and to identify reasonable mitigation measures.

D. Substantial Evidence Exists That PEX May Prematurely and Catastrophically Fail When Exposed to Numerous Commonly Encountered Environments and Building Materials

There is substantial evidence that PEX piping may prematurely degrade and rupture, causing serious water damage to homes. PEX is susceptible to chemical attack from oxidizers such as chlorine or oxygen, both from water and from the surrounding air. The attack is accelerated by heat and exposure to ultra violet rays in sunlight. Petroleum products, asphalt, certain firestopping materials and numerous other commonly encountered chemicals and materials may also accelerate degradation. These attacks eventually cause polymer chain breakage, resulting in loss of strength, brittleness, and ultimately premature mechanical failure. (See Exhibits A and B; A-33 & A-34..) Such failures tend to result in catastrophic ruptures, soaking homes and causing extensive water damage. (*Id.*)

PEX is made of material belonging to the family of plastics referred to as polyolefins.[4] All polyolefins are inherently unstable in heated water and require the presence of stabilizing additives, such as antioxidants, to maintain long-term integrity. Loss or consumption of the stabilizer package leads to failure of the piping. Research on polyolefins, including PEX, has revealed that their stabilizers are subject to both consumption and loss due to leaching from the pipe, both internally and externally. As a result, polyolefin plastic pipes are notoriously prone to premature failure.

PB pipes are in the polyolefin family. Like PEX, PB was approved by the model codes and met NSF standards. Nonetheless, PB pipes experienced massive, widespread failures resulting in billions of dollars in damages and a class action lawsuit. (See A-33.) Another polyolefin, PP tubing, also experienced similar catastrophic failures resulting in massive damages and a class action lawsuit. (*Id.*)

In his attached comments, Dr. Clark presents substantial evidence that catastrophic failures are now also occurring in PEX piping. PEX failure has been the subject of numerous lawsuits in Washington State and is a matter currently awaiting a ruling on certification of a national class action against the manufacturer. Similar failures have been reported in Canada in both open loop hydronic systems and hot potable water lines.

Premature failure of PEX presents a significant likelihood of harm because, unlike copper piping, PEX failures typically result in large catastrophic breaks. (Exhibit A at 10, Exhibit B.) When the PEX stabilizers are consumed, PEX becomes brittle and then bursts, soaking the house. Such catastrophic rupture may cause massive water damage, temporarily render the dwelling uninhabitable and

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[4] There are two primary families of plastic used to make plastic water pipe: vinyl based, which includes PVC and CPVC, and polyolefin, which includes PEX, polybutylene and polypropylene pipes. (See A-33.)

potentially result in black mold. (*Id.*) In contrast, corrosive failure in copper piping generally leads to localized penetration that provides a limited volume leak through a pin hole or small crack. (*Id.*)

Dr. Clark testifies that a broad range of commonly encountered construction materials and environmental conditions may cause PEX pipes to fail. As discussed above, PEX is very sensitive to permeation and loss of integrity in the presence of benzenes, gasoline, pesticides, termiticides and many other contaminants commonly found in soils underneath homes. (*Id.*; A-29.) Many of the same materials that may permeate through PEX pipe, may also attack and consume the PEX stabilizers as they pass through the polymer. (*Id.*) Dr. Clark characterizes this sensitivity as an "inherent weakness" of PEX. This "inherent weakness" may cause PEX pipe to prematurely fail, for example, where PEX is installed in contact with contaminated soil under slab or between the house and the meter.

One commonly used material that has been found to accelerate the loss of stabilizers in PEX is intumescent firestop material. (Exhibits A & B; see A- 29.) Firestop material is required between walls to prevent pipes from acting like a fuse and spreading fire. In his investigation of PEX failures in Washington, Dr. Clark found at least one firestop material specifically labeled safe for use with PEX pipe to dramatically accelerate the loss of stabilizer. (Exhibit B.) As a result, the PEX pipe quickly became yellow, embrittled and cracked.

Newer PEX installation guides warn against the use of firewall penetration sealing compounds with the lone exception for "water soluble, gypsum-based caulking." (A-29.) As observed generally by OSHPD, this type of limitation may be difficult to enforce. (Monograph at 3-158.) Even if drawings call for the use of water soluble, gypsum-based caulking with PEX, materials may be changed from what is approved on the drawings by contractors unaware of the repercussions of using more common intumescent firestop materials.

PEX is also extremely sensitive to sunlight. Exposure to ultraviolet ("UV") light rapidly depletes stabilizer from PEX, dramatically reducing its lifespan. (Exhibit A & B.) Dr. Clark has performed tests on PEX tubing demonstrating that some brands of PEX become virtually devoid of residual effective stabilizer after just two weeks of rooftop exposure. (Exhibit B.) At such a rate, just three days of exposure to sun at a construction site could reduce the lifespan of PEX by more than 20 percent. (*Id.*) Other studies have found a one-week exposure to sunlight sufficient to cut the resulting pipe lifetime in half. (Exhibit A.)

PEX is frequently left exposed at the worksite. Furthermore, where PEX is laid under slab and pulled up for future connections, it is left exposed for the length of time from pipe installation, slab pour, framing, and sheathing. (*Id.*) In tract housing this can be a month or more of exposure. (*Id.*)

Despite widespread acknowledgment of this problem in PEX installation guides, there are no minimum longevity standards or tests imposed for exposure to UV light. (Id.; See A-29 & A-30.) Moreover, there is no way to visually inspect PEX pipe to determine if it has been affected by UV exposure and will likely prematurely fail. (A-34.) Accordingly, consumers using PEX will have no way of knowing if the pipe they are installing has been weakened by UV exposure prior to installation. Furthermore, overexposure to UV light voids the PEX warranty. PEX consumers are thus left unprotected when such premature failures occur.

Perhaps the most commonly encountered environmental condition that accelerates the degradation of PEX stabilizers is exposure to chlorinated and oxygenated water. At least one major plumbing material retailer has refused to sell PEX due to concerns over its long-term susceptibility to damage from chlorine. (A-9.)

Common municipal disinfectant additives, such as chlorine, ozone and chloramines, increase the Oxidation Reduction Potential of the water ("ORP"). ORP is the measure of both the pH and the disinfectant of the water. Water with high ORP values have been proven to reduce the oxidative stability of polyolefins and have been directly correlated to premature failures. (See A-33.)

The stabilizer package works by incorporating antioxidants into the PEX pipe to offset the natural tendency of polyolefins to undergo oxidative degradation. (See A-33.) The antioxidants function as a sacrificial shield, being preferentially attacked and destroyed by chlorine in the water before the polyolefin is attacked. Eventually, chlorine, which is heavily used in almost all U.S. municipal water supplies as a primary disinfectant, consumes these antioxidants, leaving nothing to protect the PEX pipe. When the antioxidant is consumed, the polymer itself is attacked with resulting polymer chain breakage, ensuing loss of strength and brittleness, and ultimately mechanical failure.

The PEX manufacturer of the piping that failed in Washington State has suggested that chlorine exposure may be a contributing cause of the failures. (Exhibit B.) Most of the failures in Washington State involved open loop hydronic systems. Closed loop hydronic systems introduce chlorine only once when the system is filled and is quickly consumed as the water is recirculated throughout the system. (See A-33.) In open loop systems, as with potable water systems, fresh chlorine is reintroduced continuously and is thus constantly consuming the antioxidants. (*Id.*)

Some brands of PEX may be susceptible to premature failure when exposed to chlorine concentrations of over 4 ppm. (Exhibit A-9).) While most potable water contains less than 2 ppm of chlorine, chlorine content in municipal systems varies widely. Some municipalities deliver water containing as much as 5 ppm of chlorine. (See A-33.)

cold water supply or service system that are not addressed in this test method."

Among the obvious limits of this test is that it fails to account for cumulative attacks on the PEX stabilizer from a variety of sources. By failing to take into account likely cumulative impacts, the chlorination standard provides little assurance against premature failure.

For instance, PEX manufacturers admit that exposure to metal ions of copper and iron can promote oxidation resulting in accelerated consumption of the PEX stabilizers. (Exhibit B.) As Dr. Clark points out, potable water for domestic consumption will be oxygenated, will likely be chlorinated, and will be subject to the presence of metal ions both from the water sources and from water transmission systems. Where such a common triumvirate of conditions exists, PEX may suffer from accelerated loss of its stabilizers, potentially resulting in premature failure. (*Id.*) Exposure to ultra violet rays, organic solvents or firestop materials may also increase the likelihood that stabilizer loss from exposure to chlorinated water will result in premature failure. (*Id.*)

Such cumulative impacts are not addressed by NSF standards or testing. (*Id.*) As a result, Dr. Clark concludes that a manufacturer's claim that its piping is compliant with ASTM and NSF codes and standards is insufficient to ensure long-term serviceability under the environments commonly encountered in the intended use of PEX. (*Id.*)

Dr. Clark further points out that the mechanical performance of PEX pipe will likely vary greatly since PEX is not a single, uniform product. (*Id.*) Unlike material such as copper pipe, where conformance to ASTM specification does denote a consistency in product performance, the performance of PEX pipe is not an inherent feature of the material. Rather it depends on the stabilizers, the types,

amounts and relative amounts that are added to maintain the integrity of the structural backbone of the plastic. The design of particular stabilizer packages is considered highly proprietary and often rests not with the pipe manufacturer but with those companies formulating the resins used in the extrusion of PEX piping.

Thus, the foremost problem facing the user and the regulator is the lack of access to data that provides a basis for decisions on individual product adequacy. Indeed, many PEX piping manufacturers have not investigated and are unable to provide data on the behavior of their product under conditions of exposure that regulators should consider for safety, such as exposure to pesticides or UV sensitivity.

More than ASTM certification and PEX marketing literature is needed to determine the mechanical reliability of this product. The susceptibility of the different types and brands of PEX to premature failure cannot be determined without full disclosure of the type of antioxidants used in each type of PEX and a full evaluation of the cumulative effects of likely oxidants. Due to these concerns, preparation of an EIR is needed in order to evaluate the mechanical stability of this product.

Because the PEX portions of PEX-AL-PEX are exposed to both the same internal and external environments as PEX, PEX-AL-PEX should suffer from the same problems with stabilizer loss. (Exhibit A at 6, Exhibit B.) The aluminum center of PEX-AL-PEX may limit ruptures to an unknown degree. However, when the interior layer cracks, the aluminum is exposed to water and will itself be subject to corrosion. (*Id.*; see A-35, A-36 & A-53.) There have already been some reports of PEX-AL-PEX failures due to unknown causes. (See A-35 & A-36.) Further study in the form of an EIR is needed to determine the mechanical stability of PEX-AL-PEX when its PEX layers become devoid of stabilizers and turn yellow and brittle.

E. Substantial Evidence Exists That PEX and PEX-AL-PEX May Promote the Growth of Biofilm Containing Dangerous Pathogens

The approval of PEX may also result in significant impacts due to the tendency of PEX pipe to promote the growth of biofilm containing pathogenic bacteria such as Legionella and Pseudomonas. Both the available technical literature and Dr. Clark's research establish that the promotion of biofilms in PEX is a matter of serious concern.

Dr. Clark examined PEX piping in open loop hydronic heating systems. Open loop systems co-mingle with the potable water in the domestic water heater allowing for refreshing of the chlorine content. Dr. Clark's investigation found that, after just two or three heating seasons, significant biofilm formed in much of the PEX pipe. Bacterial counts were observed of 10,000 to 100,000CFU/cm2. Dr. Clark concludes that such bacterial counts present significant health risks, particularly for immune system compromised individuals, such as those on chemotherapy. (Exhibit C.)

Dr. Clark's investigation is consistent with several recent scientific studies on this matter. The Ministry of Public Housing, Urban Planning and Environment in the Netherlands commissioned a study on biofilm formation and pathogenic bacteria viability in common drinking water pipe. (A-37.) The study compared eight materials in the domestic water piping market, including variants of PEX, PB, PP, CPVC, PEX-AL-PEX copper and steel. The study concluded that the "PE-based materials displayed the strongest biofilm formation and the strongest promotion of the growth of Legionella bacteria." The study found that PEX-A exhibited several times the biofilm formation potential of the copper. The study also found that, even though copper pipe displayed some biofilm formation, the copper acted as a biocide killing pathogenic bacteria such as Pseudomonas and Legionella.

Numerous other studies and articles also corroborate this risk. An article by Momba, et al., warns of the risk of pathogenic and opportunistic pathogens forming and multiplying in plastic pipe biofilms. (A-38.) Several reports concluded that the presence of copper piping inhibits Legionella and reduces coliform bacteria. (A-40 & A-39.) Even Noveon, a manufacturer of both CPVC and PEX, has noted in its own newsletter the extremely high bacterial growth values for PEX as compared to CPVC. (A-41.)

A recent Norwegian study concluded that one possible reason for the high-incidence of microbiological growth in PEX piping is the leaching of VOCs from the PEX pipe itself. (A-18; see also A-19.) The VOCs apparently provide organic material for the microorganisms to consume, facilitating their growth.

The approval of PEX also raises the less obvious, but potentially significant, impact of the loss of the bactericidal properties that are inherent in using copper piping. (Exhibit C.) The Norwegian study on microbiological growth concluded that the change from copper to synthetic materials for residential installations might be a reason for increased microbiological growth. (A-18; see also A-19.) Furthermore, when problems do develop, the commonly used methods of sanitizing infected piping such as exposing them to heat or high levels of biocide chemicals can damage PEX and lead to premature failure. (Exhibit C.) Such methods would have virtually no effect on the service life of metal pipe. (*Id.*)

The susceptibility of PEX to biological growth also increases the likelihood of corrosion of metal components in a plumbing system. Dr. Clark has written a peer reviewed article on this phenomenon and has personally observed such corrosion. (Exhibit C.) Brass flow-check valves in the PEX systems he investigated in Washington State contained pinhole penetrations due to microbiologically influenced corrosion from the growth of biofilm in the PEX. (*Id.*) This increased

likelihood of premature failure of metal components is a potentially significant impact that must be evaluated in an EIR.

The risk of biofilm formation also applies to PEX-AL-PEX. The interior of PEX-AL-PEX, which is in contact with the drinking water, is identical to that of regular PEX piping and will likely exhibit the same characteristics of biofilm formation. (Exhibit C; Monograph at 3-158.) Like PEX, PEX-AL-PEX may leach VOCs, develop a layer of biofilm and potentially promote the growth of dangerous pathogens such as Legionella. (*Id.*)

Biofilm formation and increased pathogenic growth is a potentially significant impact of the proposed approval of PEX and PEX-AL-PEX. The susceptibility of PEX and PEX-AL-PEX to the formation of biofilm may lead to both significant health impacts and to premature failure of PEX and metal components. Such impacts require compliance with CEQA and must be evaluated in an EIR.

F. Substantial Evidence Exists That Approval of PEX and PEX-AL-PEX May Lead to Increased Solid Waste Impacts

Substantial evidence exists that the use of PEX may significantly impact the problem of solid waste disposal. A 2005 report by the San Francisco Department of the Environment examined the solid waste problem posed by various types of plastic pipe and found that PEX was "inherently difficult to recycle." (A-42 at 3.) The San Francisco report found that PEX was the only type of plastic piping that no plastic recycler would accept. (*Id.* at 14.)

PEX recycling is hampered by the crosslinking of the molecules. Crosslinked plastics are known as "thermoset" plastics. A thermoset plastic is hardened by curing, creating a three dimensional, inter-connected structure that cannot be remelted or remolded. It is infusible and insoluble. This makes thermosets like

PEX very difficult to recycle. The only current recycling option for PEX is to grind it down and use it as filler for another material. (*Id.* at 16.)

Copper, on the other hand, is inherently recyclable. The proposed statewide approval of PEX and PEX-AL-PEX would potentially replace a recyclable building material with a material that is inherently not recyclable. The approval of PEX and PEX-AL-PEX thus may potentially add to California's increasing solid waste disposal burden. This significant impact requires compliance with CEQA and must be reviewed and evaluated in an EIR.

G. Substantial Evidence Exists That Approval of PEX and PEX-AL-PEX Pipe May Result in Increased Fire Hazards

Mr. Reid testifies that PEX pipe may create fire hazards due to the highly flammable characteristics of PEX. He explains that although plastic pipe is not likely to be flammable if it is filled with water, it may still pose a significant concern for fire safety. (Exhibit A.) Exposed to heat in a fire, plastic pipe will rapidly rupture, draining or de-pressurizing the system and creating openings in wall studs, which may encourage fire spread. (*Id.*) Mr. Reid concludes that more information is needed to determine if firestopping measures would be adequate to address this problem. (*Id.*)

The apparent incompatibility of PEX with most firewall penetration sealing compounds may also result in significant fire impacts. Concern over this incompatibility may potentially lead contractors to forego installing necessary firestopping materials. The Commission should, at a minimum, identify which firestopping materials are appropriate for use with PEX and provide such guidance in the regulations.

PEX and PEX-AL-PEX may also pose significant risks to firefighters and households due to its potential creation of toxic smoke when burned. Further information on the toxicity of PEX smoke is needed to fully evaluate this impact.

VII. THE MONOGRAPH IS PROCEDURALLY DEFECTIVE BECAUSE IT FAILS TO INCLUDE THE PROPOSING AGENCIES' JUSTIFICATION UNDER THE NINE-POINT CRITERIA OF SECTION 18930

The California Building Standards Law requires all building standards submitted to the Commission for approval to be accompanied by an analysis written by the Proposing Agency, which shall justify the approval in terms of the nine-point criteria listed in Health and Safety Code section 18930. The nine-point criteria required under Section 18930 to justify proposed building standards are as follows:

"(1) The proposed building standards do not conflict with, overlap, or duplicate other building standards.

(2) The proposed building standard is within the parameters established by enabling legislation and is not expressly within the exclusive jurisdiction of another agency.

(3) The public interest requires the adoption of the building standards.

(4) 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.

(6) The proposed building standard 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.

(A) If a national specification, published standard, or model code does not adequately address the goals of the state agency, a statement

defining the inadequacy shall accompany the proposed building standard when submitted to the commission.

(B) If there is no national specification, published standard, or model code that is relevant to the proposed building standard, the state agency shall prepare a statement informing the commission and submit that statement with the proposed building standard.

(8) The format of the proposed building standards is consistent with that adopted by the commission.

(9) The proposed building standard, if it promotes fire and panic safety, as determined by the State Fire Marshal, has the written approval of the State Fire Marshal."

Health and Safety Code section 18929.1 requires that written notice of this nine-point justification be provided to the public for review and comment prior to its submittal to the Commission. Section 18929.1 requires that the Proposing Agencies provide for "[a]dequate public participation in the development of building standards prior to the submittal to the commission for adoption and approval." Section 18929.1 further requires "[a]dequate notice, in written form, to the public of the compiled building standards *and their justification.*" (Emphasis provided.) Finally, Section 18929.1 requires the procedures for public review to "meet the intent of the Administrative Procedure Act (Chapter 5 (commencing with Section 11500) of Division 3 of Title 2 of the Government Code) *and Section 18930.*" (Emphasis provided.)

Section 18929.1's requirement to provide the public written notice of the "justification" for the proposed building standards clearly refers to justification under the nine-point criteria of Section 18930. First, Section 18930's requirement that building standards be justified under the nine-point criteria is the only "justification" provided for in the California Building Standards Law. Second, Section 18921.1 requires the procedures for public review to meet the intent of

Section 18930, thus underscoring that this section must be consulted when justifying proposed standards to the public.

The Monograph, however, fails to provide to the public written notice of the justification for the proposed standards under the nine-point criteria analysis. Accordingly, the public has not been provided the notice and opportunity for public comment required by Section 18929.1.

This procedural defect represents a substantial failure to comply with the notice requirements of Section 18929.1 because it prevents the public from having an opportunity to review and comment on the Agencies' analyses of the nine-point criteria "prior to submittal to the commission for adoption and approval." Regulations that substantially fail to comply with notice requirements may be declared invalid. (See Gov. Code § 11350.) Under the Commission's regulations, no new issues may be raised before the Commission that were not raised during the public comment period on the Monograph. (Cal. Code Regs., tit. 24, part 1, §1-901(d)(4).) Accordingly, the failure to include the nine-point criteria justification in the Monograph effectively precludes the public from critically analyzing the Agencies' justifications for their proposed building standards.

The Monograph does include an Initial Statement of Reasons ("ISOR") as required by the APA under Government Code section 11346.2. The ISOR, however, is not equivalent to the justification under the nine-point criteria analysis required by Section 18930. The required elements of the ISOR substantially differ from the nine-point criteria listed in Section 18930. For example, unlike Section 18930, the APA does not require the ISOR to make written determinations that adoption of a proposed regulation is required by "the public interest," that adoption of a proposed regulation "is not unreasonable, arbitrary, unfair, or capricious, in whole or in part," or "that the applicable national specifications, published standards, and model

codes have been incorporated . . . where appropriate." (Gov. Code § 11346.2; see also Health & Saf. Code § 18930.)

The APA does not limit the ISOR to the elements listed in Government Code section 11346.2, so there is no bar to including the nine-point criteria analysis in the Statement. (Gov. Code § 11346.2, subd. (b) ("statement of reasons shall include, but not be limited to, all of the following . . . .").) In other words, the ISOR contained in the Monograph could have been constructed to meet the intent of both the APA and Health and Safety Code section 18930, as required under Section 18929.1. Instead, the ISORs contained in the Monograph are limited to the bare elements required under Government Code section 11346.2 and fail to include agency justifications in terms of the Section 18930 criteria. This failure violates the notice requirements of Section 18929.1. The Monograph must be revised and recirculated with a copy of the Agencies' nine-point analyses to correct this error.

VIII. THE PROPOSALS TO APPROVE PEX AND PEX-AL-PEX FAIL TO MEET AT LEAST TWO OF THE NINE-POINT CRITERIA

Before the Commission may adopt a proposed building standards, it must be satisfied that the Proposing Agency has adequately justified adoption under the nine-point criteria analysis of Health and Safety Code section 18930. The proposals to approve PEX and PEX-AL-PEX, however, fail to meet at least two of the nine-point criteria. Accordingly, the Commission may not find that these proposed standards are justified under the Section 18930 criteria.

Section 18930 requires findings under the nine-point criteria to be supported by substantial evidence. If the Commission finds a factual finding to be arbitrary or capricious or to lack substantial evidence, it shall return the standard back to the Proposing Agency for reexamination. (Health & Saf. Code § 18930, subd. (d) (1).)

In the case at hand, there is substantial evidence that approving PEX and PEX-AL-PEX, without first preparing an EIR, would be contrary to the public interest and would be unreasonable, arbitrary and unfair. Furthermore, the record lacks substantial evidence to support a contrary finding. Accordingly, the proposed approval of PEX and PEX-AL-PEX lacks justification under at least two elements of the nine-point criteria

A. Approval of PEX and PEX-AL-PEX Without First Preparing an EIR Would Not Be In the Public Interest

Approval of PEX and PEX-AL-PEX without first preparing an EIR would not meet the "public interest" element of the nine-point criteria. Health and Safety Code section 18930, subdivision (3), requires Agencies to determine if the "public interest requires the adoption of the building standards." In the case at hand, the approval of PEX and PEX-AL-PEX without first preparing an EIR would directly violate both CEQA and the *PPFA v. CBSC* holding. Such blatant defiance of the law would, in itself, be contrary to the public interest. Approval of PEX and PEX-AL-PEX also would be contrary to the public interest due to the numerous potential significant environmental, health, and safety impacts associated with these products that could adversely affect the public.

As discussed in detail above, it is well settled that the Commission and the Proposing Agencies must comply with CEQA prior to adopting new building standards that may have a significant impact on the public health, safety or the environment. Furthermore, it is well settled that compliance with CEQA is in the public interest. (See *Kane v. Redevelopment Agency of City of Hidden Hills* (1986) 179 Cal.App.3d 899, 905; *People By and Through Dept. of Public Works v. Bosio* (1975) 47 Cal.App.3d 495, 526; see also Pub. Resources Code § 21000.) CEQA "protects not only the environment but also informed self-government." (*Communities for a Better Environment v. Calif. Resources Agency, supra,* 103 Cal.

App. 4th at p. 108.) CEQA informs the public and its responsible officials of the environmental consequences of their decisions before they are made, ensuring consideration of alternatives and requiring imposition of reasonable mitigation measures. (*Id.*; Pub. Resources Code §§ 21063 & 21100.) Failure to comply with CEQA prior to the adoption of PEX and PEX-AL-PEX would thus be contrary to the public interest in ensuring informed self-government and in protecting public health, safety and the environment.

In addition, adoption of the proposed amendments without first complying with CEQA would directly violate the court's holding in the case *PPFA v. CBSC*. The Court of Appeal in that case clearly stated that approval of PEX requires environmental review. As discussed in detail above, the court's holding in that case is binding upon the Commission and the Proposing Agencies both as case law and under the doctrine of collateral estoppel. Failure to disclose, analyze and mitigate the potential impacts of PEX and PEX-AL-PEX prior to approval would violate both CEQA and the court's express holding. Such blatant defiance of the law, on its face, is contrary to the public interest and may not be justified under the nine-point criteria.

Furthermore, substantial evidence exists that approval may result in significant environmental, health, and safety impacts that could adversely affect the public. As detailed above, the approval of PEX and PEX-AL-PEX may result in:

- The contamination of drinking water due to leaching of chemicals such as MTBE and TBA in levels that exceed California public health standards;
- The contamination of drinking water due to the permeation of PEX piping by pesticides, termiticides, benzene, gasoline constituents and other toxic chemicals;
- Premature degradation and rupture of PEX pipe due to exposure to numerous commonly encountered materials and environmental

conditions, including sunlight, high temperatures, chlorine, petroleum products, firestopping material and asphalt;

- Increased risk of biofilm formation containing dangerous pathogens such as Legionella;
- Increased solid waste disposal impacts; and
- Increased risk of fire hazard from toxic smoke and fire spread.

Approval of PEX and PEX-AL-PEX without full disclosure, evaluation and mitigation of these impacts would not be in the public interest and thus may not be justified under the nine-point criteria.

B. Approval of PEX and PEX-AL-PEX Without First Preparing an EIR Would Be Unreasonable, Arbitrary and Unfair Because it Would Violate State Law and the Court of Appeal Decision

Health and Safety Code section 18930, subdivision (4), requires Proposing Agencies to justify their proposed building standards on the grounds that the proposed standard "is not unreasonable, arbitrary, unfair, or capricious, in whole or in part." In the case at hand, it is manifestly unreasonable, arbitrary and unfair to propose the adoption of building standards that violate state law and violate the express, binding decision of the California Court of Appeal. As discussed above, the approval of PEX and PEX-AL-PEX without first preparing an EIR would violate both CEQA and the *PPFA v. CBSC* decision. Since it would be unreasonable, arbitrary and unfair to approve building standards in a manner contrary to law, such approval may not be justified under the nine-point criteria.

Furthermore, the proposed approval of PEX and PEX-AL-PEX is unfair and unreasonable due to the substantial evidence of potential significant impacts associated with these materials. Approval of a building material without first requiring full disclosure, evaluation and mitigation of its potential impacts is unfair to the public. Moreover, a proposal by an agency to have a potentially hazardous

building material approved without such disclosure, evaluation and mitigation is unreasonable.

IX. THE MONOGRAPH FAILS TO IDENTIFY THE PROPOSED CHANGES TO THE CALIFORNIA BUILDING STANDARDS CODE AND THUS VIOLATES THE NOTICE REQUIREMENTS OF THE APA

Health and Safety Code section 18929.1 requires that Proposing Agencies provide "[a]dequate notice, in written form, to the public of the *compiled building standards*." (Emphasis provided.) Section 18929.1 further requires the procedures for public review to "meet the intent of the Administrative Procedure Act (Chapter 5 (commencing with Section 11500) of Division 3 of Title 2 of the Government Code)." Under the APA, notice of proposed standards must be accompanied by a copy of the express terms of the proposed regulations. (Gov. Code § 11346.2, subd. (a) (2).) The APA further requires agencies to "use underline or italics to indicate additions to, and strikeout to indicate deletions from, the California Code of Regulations." (Gov. Code § 11346.2, subd. (a) (3).)

The Monograph, however, fails to provide the public with adequate notice of proposed changes to the California Code of Regulations. Both HCD and DSA, for example, fail to indicate, by underline, italic or any other method, the *changes* between this proposed section and the current version of CPC section 604.1. (See Monograph at p. 3-207.) Instead, they provide only the new proposed text of CPC section 604.1 with no indication that it contains changes. In particular, HCD and DSA fail to identify the material PEX-AL-PEX as a new addition to this section.

The CBSC's failure to adequately identify the proposed regulations in its notice is even more egregious. CBSC not only fails to expressly identify the addition of PEX-AL-PEX to Section 604.1 as a change from the current version of section 604.1, it further fails to provide even the proposed text to this section. (Monograph

at 3-132.) Accordingly, the Monograph provides the public absolutely no notice of this proposed change.

These defects are substantive and material because they hide from the public the changes being proposed to the California Code of Regulations. The Monograph should be revised and recirculated to provide the public actual notice of what changes are being proposed. Proper notice should identify any changes clearly through the "use of underline or italics to indicate additions to, and strikeout to indicate deletions from, the California Code of Regulations."

X. THE HCD, CBSC AND DSA INITIAL STATEMENTS OF REASONS VIOLATE THE APA BY FAILING TO PROVIDE A RATIONALE FOR THE ADDITION OF THE APPROVAL OF PEX-AL-PEX TO CPC SECTION 604.1

The Initial Statements of Reasons of HCD, CBSC and DSA fail to provide a "statement of purpose" or "rationale" for the proposed approval of PEX-AL-PEX. Accordingly, these ISORs are procedurally defective. The ISORs required by the APA must include "a statement of the specific purpose" of each new or amended regulation and a "rationale for the determination" by the agency that the change is "reasonably necessary." (Gov. Code § 11346.2, subd. (b)(1).) The ISORs provided by HCD, CBSC and DSA in the Monograph, however, fail to even mention the proposed addition of PEX-AL-PEX to CPC section 604.1, much less provide a justification for its addition to the code. This procedural defect is substantive since it prevents the public from reviewing and commenting on the Agencies' rationale for approving PEX-AL-PEX.

the time it made these findings and are thus arbitrary and capricious. Furthermore, these findings are each contradicted by the evidence currently before the Commission, including this letter and the attached exhibits and appendices.

A. HCD's Finding That There Is No Evidence That PEX May Prematurely Fail Due to its Similarities to PB Is Contrary to the Evidence in the Record

In the Literature Search, HCD asserts that there is no evidence to support Mr. Reid's testimony that PEX is a similar plastic as PB and thus may be prone to premature failure. (Literature Search at 1.) HCD bases its rejection of Mr. Reid's expert analysis on the statement that "literature shows that the chemical composition between PB and PEX is different and the two materials cannot be assumed to be the same." HCD then states that PB is a thermoplastic formed by polymerization of 1 butene, while PEX is a thermoplastic formed by polymerization of ethylene.

This argument is misleading and disingenuous. Furthermore, this claim lacks relevancy. Mr. Reid never claimed that PB and PEX had the *exact same* chemical composition or were the *exact same* products. Rather, Mr. Reid stated that they belonged to the same family of plastic referred to as polyolefins. Mr. Reid testified that this family of plastics is prone to premature failure and requires the use of stabilizing additives such as antioxidants to maintain long-term integrity. HCD's Literature Search references no evidence or analysis to rebut this testimony. Accordingly, its rejection of this testimony is arbitrary and capricious.

The Literature Search further states, "because the chemical structures are different it cannot be assume [sic] that a defect found in the use [sic] PB pipe will

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these statements fail to provide any foundational support for the claim that "there is no basis in the record to exclude [PEX]."

appear as a similar defect in the use [sic] PEX as water pipe." HCD, again, provides no evidence or analysis to back up this conclusion. Furthermore, this conclusion is contrary to the evidence that was before HCD at the time it prepared this review, including Mr. Reid's 2001 expert comments and the PEX manufacturer's own installation guides warning against the exposure of PEX to sunlight, heavily chlorinated water and other oxidants.

In his 2001 comments, Mr. Reid provided expert testimony that cross-linking does not change the fundamental chemistry of polyolefin polymers and hence PEX is susceptible to the same chemical attack from oxidants or ultraviolet light as are other polyolefins such as PB. For this reason, PEX, like PB, uses chemical additives such as antioxidants to prevent mechanical failure. When the antioxidants are consumed, PEX, like PB, will fail.

The Literature Search provided no evidence or analysis to rebut Mr. Reid's expert opinion. Furthermore, it ignored the evidence that was before it, including Mr. Reid's expert testimony. Accordingly, HCD's dismissal of Mr. Reid's conclusion that PEX may be susceptible to similar mechanical failures as PB was arbitrary and capricious and is not entitled to any deference by the Commission.

New evidence submitted in the current proceeding further contradicts HCD's finding that there is no evidence to support Mr. Reid's opinion. This evidence includes the comments of Dr. Clark, which corroborate that PEX is similar to PB and is susceptible to chemical attack from a large number of commonly encountered oxidizers such as chlorine, ozone, metal ions, fire sealants and sunlight. (Exhibit B.) This evidence also includes a technical bulletin from a leading plastic pipe manufacturer, which admits that all polyolefins, including PEX and PB, are subject to attack from antioxidants. (A-33.)

B. HCD's Finding That There Is No Evidence That PEX Is Subject to Attack by Chlorine Water Is Contrary to the Evidence in the Record

HCD claims that "the literature" indicates that PEX piping and fittings are not subject to attack by chlorine. (Literature Search at 2.) Again, HCD provides no evidence to back up this claim. The record of its review of PEX provided by HCD contains no "literature" or other evidence establishing that PEX piping is not subject to attack by chlorine.

To the contrary, the evidence before HCD, including the expert opinion of Mr. Reid and the PEX installation guides and chemical resistance guides, demonstrate that PEX may be subject to attack by chlorine. Moreover, HCD acknowledges that NSF International now tests PEX piping to establish that it provides a minimum "resistance" to attack by chlorine in the water supply. Because it lacks any evidentiary foundation, HCD's finding that there is no evidence that PEX is subject to attack by chlorine water is arbitrary and capricious and is not entitled to any deference by the Commission. (See Health & Saf. Code § 18930, subd. (d)(1).)

C. HCD's Finding That There Is No Evidence That PEX Has Prematurely Failed in a Significant Number of Cases Lacks Relevancy and Is Contrary to the Evidence in the Record

In its Literature Search, HCD states that "there have been no reports of mass structural failures of PEX pipe such as occurred with PB." (Literature Search at 1.) This statement, however, lacks relevance since it wrongly suggests that premature failure of PEX is only significant if it occurs in the same scope and breadth as the PB failures.

Furthermore, this statement grossly mischaracterizes Mr. Reid's 2001 testimony. Mr. Reid never claimed that PEX was currently failing at the same massive scope and rate as PB. Rather, Mr. Reid testified that PEX may be

susceptible to premature failure depending upon the type of additives in the pipe and the aggressiveness of oxidizer exposure and environmental conditions.

Moreover, at the time HCD prepared the Literature Search, it was aware of reports of catastrophic PEX failures at the Blueberry Place condominium complex in Washington State. (See Exhibits E-G.) HCD dismisses these reports by concluding that the failures in Washington appear to be due to handling and installation of PEX rather than due to an inherent structural problem with the product itself. This conclusion, however, is based upon speculation rather than fact or expert analysis. This conclusion also contradicts HCD's own statement, just a few paragraphs earlier, that HCD was informed that the defendants in the subsequent litigation over the Blueberry Place failures "admitted the tube was defective." (Literature Search at 2.)

In its Literature Search, HCD concludes that the Blueberry Place failures could not have been due to inherent structural problems with PEX because only 19 out of 57 units experienced water damage due to PEX failures. (*Id.*) This conclusion, however, is mere speculation and lacks any factual foundation. Moreover, this conclusion is illogical as it is hard to fathom how a thirty-four percent (34%) failure rate could not be considered to potentially suggest structural problems. (See Dr. Clark comments, Exhibit B.)

The evidence submitted by Dr. Clark further contradicts the Literature Search's conclusions. This evidence shows that one hundred percent (100%) of the units at Blueberry Place had PEX that was severely damaged, even though only thirty-four percent (34%) of the units had actual PEX ruptures before the problem was discovered. (Exhibit B.) Dr. Clark also testifies that the PEX manufacturers admit that chlorine exposure may be a contributing cause of the failures. (*Id.*)

Finally, at the time that HCD prepared the Literature Search, it had been advised that PEX piping was beginning to fail in Canada and possibly in Europe as well. On August 13, 2003, HCD was forwarded an e-mail that had been sent unsolicited to the Governor's Office of Planning and Research from Scott MacKay, president of EnerMac Consultants, Inc., a consulting firm located in Alberta, Canada. (A-49.) In this e-mail Mr. MacKay stated that he had read that California was considering the approval of PEX piping and that he thought they should be aware that PEX was starting to fail in Washington State and in Canada. (*Id.*) He warned that these failures "could be major to our industry." He also stated that he had a couple of studies that identified PEX failures in Europe. (*Id.*) Finally, Mr. MacKay invited California officials to e-mail him back if they needed any further information.

Despite receiving this information right around the time that the February 2004 Literature would have been drafted, HCD's responses to public record requests reveal that they neither e-mailed Mr. MacKay, nor followed up on any of the information that he supplied them. Furthermore, HCD arbitrarily failed to include this information in its Literature Search.

Dr Clark, in his comments, has confirmed that there have been reports of PEX failures in potable water systems in Canada. (Exhibit B.) He also testifies that there have been numerous other cases of PEX failures in Washington State in addition to the Blueberry Place failures. (*Id.*)

By deliberately failing to follow up on information that was provided them on PEX failures in Canada and Europe, HCD reveals that it had no intention of providing a credible and serious analysis in its Literature Search. The Literature Search's conclusion that no evidence exists that PEX may prematurely fail is thus contrary to the evidence before it, lacks foundation and is arbitrary and capricious.

D. HCD's Finding That There Is No Evidence That PEX May Leach Dangerous Chemicals Is Contrary to the Evidence in the Record

HCD concedes in the Literature Search that there is evidence from an Arizona lawsuit that PEX pipe has been found to leach MTBE in concentrations near or above 20 ppb. (Literature Search at 6.) HCD further admits that NSF/ANSI testing will certify PEX that leaches as much as 50 ppb. (*Id.*) Rather than conceding that this is a significant impact, HCD dismisses the Arizona complaint as merely involving taste and odor, not poisoning.

HCD's dismissal of this evidence is arbitrary and capricious for several reasons. First, even if the MTBE did not "poison" anyone, that does not mean it did not present a health risk. Second, HCD appears to have arbitrarily applied the health-based level set by NSF/ANSI, private organizations, as opposed to applying the health-based level set by the State of California. The 50 ppb level set by NSF/ANSI is ten times the California taste and odor threshold and four times the California primary MCL and PHG level. Third, there is no evidence that HCD investigated the level of leaching at which MTBE is considered a health risk by the State of California. Fourth, HCD arbitrarily dismisses the significance of taste and odor impacts on drinking water quality. Fifth, HCD ignores and fails to address the evidence from the Arizona lawsuit that PEX may also leach significant amounts of TBA. Finally, HCD ignored Wirsbo's disclosure statement in the Arizona lawsuit that admitted PEX may leach MTBE and TBA.

HCD also claims in its Literature Search that there are no PHGs established by OEHHA for any potential contaminant in the material of PEX pipe. This is simply untrue. OEHHA adopted a PHG for MTBE of 13 ppb in 1999. (A-17 & A-21.) In addition, DHS has also set a health-based primary MCL of 13 ppb for MTBE, as well as a secondary MCL of 5 ppb for taste and odor. (A-16, A-51.) DHS has also set an action level of 12 ppb for TBA. (A-22.)

HCD's selective, misleading, and inaccurate use of the evidence it had available before it was arbitrary and capricious. Furthermore, the evidence that HCD did acknowledge did not support the findings that followed.

Mr. Reid's updated comments and attached evidence further contradict HCD's finding that there is no evidence of significant PEX leaching. Mr. Reid's updated comments demonstrate that the leaching of PEX may result in significant cumulative impacts due to the widespread preexisting contamination of California's drinking water with MTBE. Another analyst has found TBA to leach in concentrations of up to 10,000 ppb where water has been sitting stagnant in PEX. (A-14.) Studies in Norway have also confirmed that MTBE, TBA and other VOCs may leach from PEX, causing both significant taste and odor impacts and significant health risks. One study found MTBE to leach from PEX pipe in concentrations up to 47 ppb. (A-19.) In addition, numerous studies have found both MTBE and TBA to be potentially carcinogenic to humans. (A-15, A-20, A-21, A-44, A-50 & A-51.)

New evidence further shows that other California agencies disagree with HCD's findings. OSHPD, for example, found that studies have demonstrated that PEX is susceptible to chemical leaching and this leaching may be harmful to persons with weakened or impaired immune systems. (Monograph at 3-158.)

HCD's finding that there is no evidence the leaching from PEX may contaminate drinking water is thus contrary to the evidence before it and is arbitrary and capricious.

fact that it was the PEX manufacturer, itself, that claimed that benzene found in the plaintiff's drinking water was due to the termiticide in the soil surrounding the buried pipe. (A-12.)

HCD's analysis also ignores the evidence that PEX may be susceptible to permeation by other contaminants in addition to termiticide. For example, Wirsbo disclosed in the Arizona case that PEX is subject to permeation from solvents, fuels, organic compounds and other materials. (A-12 at 2.)

The new evidence submitted in the current proceeding further contradicts HCD's conclusion that no evidence exists of permeation risks. This evidence includes the updated comments of Mr. Reid and numerous plastic pipe industry documents further disclosing the risk of permeation. (A-29 at 4.) For example, a technical document prepared by the Plastics Pipe Institute states that thermoplastic pipes such as PEX "should not be used where a permeating chemical could compromise the purity of a fluid such as potable water inside the pipe." (A-32.)

HCD's determination that there is no record in California of drinking water being contaminated by pesticides permeating through PEX is irrelevant to the question before the Commission: whether contaminants may potentially permeate through PEX pipe. Moreover, to the extent that HCD claims to have concluded that no evidence exists that PEX is susceptible to permeation by pesticides, termiticides or other contaminants, such a conclusion is substantially unsupported by the evidence and must be disregarded by the Commission.

F. HCD's Determination That There Is "No Basis to Exclude" PEX Has No Relevance to the Determination of CEQA Applicability and Does Not Invoke the Common Sense Exemption

The Commission is not required to defer or give any weight to a Proposing Agency's factual determinations as to whether the approval of a proposed building

standard may result in a physical change on the environment requiring compliance with CEQA. Section 18930, subdivision (d)(1), requiring the Commission to give great weight to the determinations and analysis of the Proposing Agency, applies only to factual determinations regarding the nine-point criteria. Thus, on its face, section 18930 does not apply to factual determinations regarding the applicability of CEQA.

Furthermore, to the extent that HCD's finding that there is "no basis to exclude" PEX is based on its weighing of competing evidence, this finding has no relevance to the determination of whether environmental review under CEQA is required. The fair argument standard prohibits an agency from weighing competing evidence to determine who has a better argument concerning the likelihood of a potential impact. (See *No Oil, Inc. v. City of Los Angeles* (1974) 13 Cal.3d 68, 75, 82-83.) Thus, a conclusion based upon the weighing of evidence is not applicable to the determination of whether CEQA review is required. Moreover, CBSC is independently required to comply with CEQA before adopting regulations.

Even if HCD were to claim that it did not weigh evidence, the finding that there is "no basis to exclude" PEX is still insufficient to invoke the "common sense" exemption to CEQA. Under the "common sense" exemption, an action is exempt from CEQA "[w]here it can be seen with *certainty* that there is *no possibility* that the activity in question may have a significant effect on the environment." (CEQA Guidelines § 15061 (b)(3); emphasis added.) The courts have held that this exemption is extremely narrow. If a reasonable argument is made to suggest a possibility that a project will cause a significant impact, the agency "must refute that claim *to a certainty* before finding that the exemption applies." (*Davidon Homes v. City of San Jose* (1997) 54 Cal.App.4th 106, 117-118 (emphasis in original).) Accordingly, the Commission would be required to reject an argument that HCD's finding invokes the common sense exemption if it was presented with

even the slightest of evidence that the proposed approval of PEX and PEX-AL-PEX may have a significant effect on the environment.

While HCD's Literature Search disagrees with many of the claims made by Mr. Reid in his 2001 comments, it offers no analysis or evidence refuting Mr. Reid's claims to a certainty. Furthermore, HCD's Literature Search ignores several potential impacts entirely, including biological growth, solid waste disposal and fire safety impacts. HCD's Literature Search also completely ignores any potential impacts from the approval of PEX-AL-PEX. Finally, HCD's Literature Search does not address, and thus cannot claim to refute, any of the new comments and evidence presented herein. As a result, when the Commission reviews the proposed Project for compliance with CEQA, it may not give any weight to HCD's determination that there is "no basis to exclude" PEX.

XII. NSF CERTIFICATION IS INADEQUATE TO REFUTE THE EVIDENCE THAT PEX AND PEX-AL-PEX MAY HAVE A SIGNIFICANT IMPACT ON THE ENVIRONMENT

A. The *PPFA v. CBSC* Court Determined that CEQA Applies to the Approval PEX Even Though It Is NSF Certified

The Court of Appeal in *PPFA v. CBSC* implicitly rejected any argument that NSF certification was adequate to refute evidence that a building material may have a significant impact on the environment. The court observed that PEX was certified by NSF International, but noted evidence that "NSF expressly disclaims any responsibility for the decision whether to use a certified product, does not make its test results available to others to review, and limits its testing protocols based on undisclosed assumptions derived from information provided by manufacturers." (*PPFA v. CBSC, supra,* 124 Cal.App.4th at pp. 1399-1400.) The court then proceeded to hold that substantial evidence existed that PEX may present public health and safety concerns despite the NSF International certification. (See *Id.* at 1407.) Finally, the court held that PEX could not be approved until its potential

impacts were reviewed under CEQA. (*Id.* at 1415.) This decision, thus, refutes any argument that NSF certification is somehow a shield against further environmental and health and safety review.

B. NSF Expressly Disclaims any Responsibility for Providing Safety Requirements

NSF itself does not claim that its certification is adequate to ensure that there is no potential for any significant impacts from the use of PEX or PEX-AL-PEX. As noted by the Court in *PPFA v. CBSC*, NSF expressly disclaims responsibility or liability to "*anyone*" relying on its standards or testing and emphasizes the importance of independent judgment and regulatory action by any public agency relying on its standards:

> "NSF International (NSF), in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of NSF represent its professional judgment. *NSF shall not be responsible to anyone for the use of or reliance upon this standard by anyone.* NSF shall not incur any obligations or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this standard. [¶] Participation in NSF's standards development activities by a regulatory agency (Federal, state, local) shall not be construed as the agency's endorsement of NSF, its policies, or any of its standards." (Appendix 21, p. iii.)

Such a disclaimer underscores the need to conduct an independent assessment of the basis for those standards. Without such an assessment, it is impossible to know what these standards actually mean and to what extent they can be relied upon to resolve effects that are potentially significant.

For example, the NSF 61 Standard sets forth the health risk assessment methodology applied by NSF in setting allowable levels of contaminants in drinking water. While examination of that methodology is an important starting point in HCD's evaluation of the NSF action level determinations, a review of the methodology alone is not sufficient to determine the adequacy of those levels in protecting public health. NSF's analytical method could produce a wide range of action level determinations depending on the specific toxicity data and assumptions used in applying that method to the analysis of particular contaminants. A review of the underlying toxicity studies and data considered by NSF in applying the NSF 61 methodology is essential to any meaningful review of the adequacy of the NSF determinations regarding allowable levels of contamination.

C. The Record Contains Ample Evidence That NSF Standards and Testing Are Not Adequate to Establish a Product's Safety and Lack of Impact on the Environment

As discussed in detail in the technical comments attached as exhibits to this letter, the NSF standards, testing and certification process are not adequate to ensure protection of the public health.

The attached expert comments, including the attached Mr. Reid comments, Dr. Clark comments demonstrate numerous substantive deficiencies in NSF standards, including the following:

1. Many of NSF allowable levels of contamination are too high to adequately protect human health.

2. NSF relies on Manufacturer's assertions of product formulas and fails to independently test materials as done in some foreign countries.

3. NSF accepts "range formulas" without disclosure of actual formulas to NSF.

4. NSF "normalization calculation" to estimate "at-the-tap" exposures significantly underestimates exposures for residential plumbing installations.

5. NSF expressly retains the discretion in applying NSF 61 to certify products even where the exposure concentration is in excess of the maximum contaminant level established by NSF for the contaminant.

6. Entire NSF testing and certification process is confidential.

7. NSF is a private entity and not accountable to the public.

8. NSF's operations are almost entirely funded by manufacturers of plumbing products listed and tested by NSF.

9. NSF standards for unregulated contaminants are established largely on the basis of toxicity information and studies provided by and owned by the manufacturers of the regulated products.

10. NSF's standards setting and testing-processes are dominated by the industrial participants that have an economic stake in the results of the process.

The attached expert comments further demonstrate that PEX certification under the ANSI/NSF Standard 61 does not disclose or provide any assurances regarding PEX and PEX-AL-PEX's chemical leaching potential. For example, NSF has revealed in correspondence with HCD that they will certify PEX pipe that leaches up to 50 ppb of MTBE. (A-24.) This is almost four times the primary MCL for MTBE set by DHS and is ten times the secondary MCL set for taste and odor. Furthermore, while NSF has recently instituted a test for chlorine resistance, it fails to consider the numerous other commonly encountered causes of oxidative degradation such as sunlight and contaminated soils or their cumulative effects. In addition, NSF certification does not consider, at all, the solid waste, permeation, biofilm, or fire hazard impacts presented by the proposed approval of PEX and PEX-AL-PEX.

D. Agencies May Not Delegate To A Private Organization Their Duty Under CEQA to Independently Review the Potential Impacts of a Proposed Building Material

Even if NSF International did consider all of the potential impacts raised in this comment, the Commission and the Proposing Agencies still could not delegate to NSF their duty under CEQA to independently review the potential impacts of a proposed building material. CEQA requires that a lead agency independently review and analyze the potential impacts of a project. (Pub. Resources Code § 21082.1(c)(1).) It also requires that determinations under CEQA reflect the lead agency's independent judgment. (Pub. Resources Code § 21082.1(c)(2).) Any reliance on NSF Certification must be the result of careful evaluation of the standards for such certification. That evaluation must include the ability of the standard to resolve effects that are potentially significant.

Even apart from CEQA, a determination of the level of drinking water contamination that would be allowed by the regulatory approval of a plumbing product coming in contact with that water constitutes an exercise of the police power that cannot be delegated to a non-governmental entity. The Commission and the Proposing Agencies have a legal responsibility to protect the public health and safety that cannot be delegated to private organizations under settled principles of constitutional law. (See *International Ass'n of Plumbing and Mechanical Officials v. California Building Standards Com'n* (1997) 55 Cal.App.4th 245,253-254; 63 Ops.Cal.Atty.Gen. 566 (1980).) Any reliance on private standards in adopting state regulations would require the exercise of the Commission's and the Proposing Agencies' independent assessment of the adequacy of the standard. (*Id.*) Reliance on NSF's standards would be constitutionally permissible only if the Commission and the proposing agencies independently evaluated the adequacy of such standards to protect California drinking water consumers.

XIV. CONCLUSION

The evidence that PEX and PEX-AL-PEX may have a significant effect on the environment is overwhelming. Chemicals such as MTBE, TBA and various benzene-type aromatic hydrocarbons may leach directly out of PEX Pipe and PEX-AL-PEX Pipe and contaminate drinking water. PEX may fail when exposed to high levels or multiple sources of oxidants such as chlorine, sunlight and petroleum-contaminated soils. Pesticides, termiticides, benzene, gasoline constituents and other toxic chemicals may permeate PEX pipe and enter drinking water. PEX and PEX-AL-PEX pipe may promote the growth of biofilms containing dangerous microbes such as Legionella. The replacement of recyclable copper piping with non-recyclable PEX and PEX-AL-PEX pipe may increase solid waste disposal issues. And, finally, PEX and PEX-AL-PEX pipe may pose fire and smoke inhalation hazards.

The proposed adoption of building standards allowing the use of PEX and PEX-AL-PEX without first complying with CEQA ignores this overwhelming evidence of potentially significant environmental impacts and violates state law. It also openly defies the Court of Appeal's holding in *PPFA v. CBSC*.

Furthermore, the Monograph suffers from numerous procedural deficiencies. It fails to provide proper notice of proposed code changes or their justification. What little analysis it does provide, is contrary to the evidence and is arbitrary and capricious.

The Coalition for Safe Building Materials respectfully requests that the Commission require full compliance with CEQA, including the preparation of an EIR, prior to amending the CPC to allow the use of PEX or PEX-AL-PEX. The Coalition further requests that the procedural defects in the Monograph be corrected. HCD's proposal to approve the use of PEX and HCD's, CBSC's and DSA's proposal to approve

the use of PEX-AL-PEX should be disapproved or, in the alternative, further study should be required.

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July 15, 2005
TRA File: LPPC

Thomas A. Enslow
Adams Broadwell Joseph & Cardozo
1225 8th Street, Suite 550
Sacramento, CA 95814

Re: Comments on California Department of Housing and Community Development consideration of the use of PEX as potable water pipe

Dear Mr. Enslow:

The California Department of Housing and Community Development ("HCD") has been considering the approval of Crosslinked Polyethylene (PEX) potable water tubing for several years. During this time, I have written comment letters raising fundamental concerns over the public health, consumer protection and environmental effects of PEX. Comment letters of mine that have been submitted to the California Building Standards Commission (BSC) include:

July 23, 2001	Environmental effects of California adoption of PEX for potable water.
April 3, 2002	Information on environmental effects of PEX use for potable water.
January 13, 2003	Additional information substantiating the potentially significant public health, consumer protection, and environmental effects of adopting PEX pipe for potable water use.
September 9, 2003	Environmental effects of California adoption of PEX-AL-PEX for carrying potable water.

The thrust of my comments have been 1) that HCD had a real obligation to conduct an independent assessment of several issues prior to granting broad approval of PEX for potable water use in California, and 2) those issues should be resolved by HCD using a open, objective process as provided by the California Environmental Quality Act (CEQA). This previous communication is still relevant and is incorporated in my current comments.

1. HCD's environmental record is incomplete and does not serve as a basis for PEX approval.

In February 2004, HCD published "HCD Literature Search Concerning on (sic) the Use of PEX as Potable Water Pipe" which is a summary of the Department's study on several issues, most notably an effort to rebut points raised in my earlier communication. Apparently, the "Literature

Search" (LS) and some correspondence with PEX manufacturer Uponor Wirsbo and NSF International are the full extent of HCD's research as indicated by HCD's response to a Public Records Act request submitted by the law firm of Adams, Broadwell, Joseph and Cardozo.

The LS itself cites only a handful of external references and does not contain a list of documents, nor does it identify the persons conducting the search or describe their qualifications to reach the conclusions rendered. Several state agencies are mentioned, but the names or qualifications of the persons advising HCD are not given. Repeatedly, the LS denies a problem stating ""the literature shows" or the "literature indicates" without giving any list of how extensively the literature was actually consulted.

The LS does not meet CEQA disclosure standards for an EIR: Guidelines section 15129 requires an EIR to "identify all federal, state, or local agencies, other organizations, and private individuals consulted in preparing the draft EIR, and the persons, firm, or agency preparing the draft EIR, by contract or other authorization." Section 15087(c)(5) requires a location readily accessible to the public where "all documents referenced in the EIR will be available for public review". The purpose is to let the public know who is advising the lead agency.

The "Literature Search" document is opinionated, argumentative and factually unsound. By its tone and reliance on irrelevant facts, the HCD document seems to have been drafted by someone more used to marketing plastics than protecting Californians. This anonymous document is completely unsuited to serve the state as a basis of decision making on the important subject of public health consumer protection, and environmental quality.

In this letter, I present the main issues that HCD must consider before approving PEX and address the errors in the HCD LS where appropriate.

2. Mechanical Failure

The issue of mechanical failure involves the complex of factors that affect the service life of PEX installations and the mode of failure.

In brief, PEX is subject to oxidative chemical attack by chlorine in drinking water and by oxygen both from water and from the surrounding air. The attack is accelerated by heat and exposure to ultra violet rays in sunlight. Pipe manufactures blend antioxidants in the pipe to resist the oxidative attack, but these AO are gradually consumed and the pipe matrix eventually fails.

The "Literature Search" erroneously concludes that chlorinated water is no problem.

In earlier comment letters, I cited extensive information about the role of oxidation in potential mechanical failure. HCD simply ignores this real issue; the LS states "1. PEX

is not a similar plastic as PB as suggested by Thomas Reid." and "2. PEX is not subject to attack by chlorine in water as suggested by Thomas Reid."

In fact, the literature shows that industry experts share my concern over PEX attack by chlorine in water:

1) "Environmental factors, and their effect on piping materials, such as installation methods and operating conditions have been well characterized. The influence of the transported fluid on piping materials is becoming better understood, particularly for PEX tubing. The chlorine residual employed to disinfect potable water is known to increase the oxidative potential of the water in question. The effect of the chlorine residual on PEX pipe has been shown to be primarily an oxidative one. Estimated pipe test lifetimes have been directly correlated to the level of oxidative strength of the potable water." ("Oxidative Resistance of Sulfone Polymers to Chlorinated Potable Water", S. Chung, J. Couch, J.D. Kim, K. Oliphant and P. Vibien, Jana Laboratories Inc., 280B Industrial Parkway S., Aurora ON, Canada and J. Hung, M. Ratnam and W. Looney, Solvay Advanced Polymers, LLC, 4500 McGinnis Ferry Road, Alpharetta, GA; Society of Plastics Engineers Annual Technical Conference (ANTEC) 2003.)
2) "Like other polyolefin products, the base PEX polymer, without additional additives, offers little resistance to oxidation, and would oxidize in the presence of typical chlorinated potable water. For this reason, all PEX manufacturers use engineered additive packages containing antioxidants. The antioxidants are sacrificial in nature and serve to protect the PEX polymer from chlorine's oxidative attack." ("Comparison of the Two Nationally Accepted Rating Systems for Chlorine Resistance of PEX Water Piping", Frank R. Volgstadt; Plumbing Engineer, April 2004)
3) "Hydrocarbons (such as PEX) break down (age) as they eventually combine with oxygen (oxidize). To prolong this process, plastic pipes are infused with an antioxidant (AO) package of chemicals which stabilize the finished product against such oxidative break down. Chemists have, in a sense, discovered the fountain of youth for plastics among the wide range of antioxidants. The performance of plastic pipes depends on the adequacy of the antioxidant stabilization package, the distribution of antioxidants within the product, and the ability of the antioxidant to remain within the material for a long periods of time when exposed to harsh environments." (http://www.tesmar.com/html/in_defense_of_silane.html; "Tom Tesmar is an industry consultant specializing in the field of emerging technology for heating and plumbing systems. Tom can be reached at Tesmar Application Technology, 595 Tower Road, Hudson, WI 54016")
4) Noveon IP, the successor to B.F. Goodrich's plastic pipe resin business and a major manufacturer, patented a tube design with "The inner tubular core of protective polymer is high-density polyethylene and chlorinated polyethylene contiguous with the inner surface of the PEX." and claimed, "ADVANTAGE The tubing or pipe has improved resistance to chlorine and hypochlorous acid contained in potable water." ("Pipe or tubing of crosslinked polyethylene, useful

for potable water applications and hot water heating systems, has wall of uniform thickness and contains dispersed carbon black" US Patent 20040020547.)

5) The problem is indeed so well known in industry that a specific standard testing method has been formulated: "Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water" ASTM F2023-04.

For the record, HCD needs to acknowledge that oxidative failure, particularly provoked by chlorinated water, is a real problem for PEX piping.

PEX use history in Europe and for radiant heating is not a guarantee of service in United States potable water applications.

PEX proponents and HCD rely on PEX history of use in Europe and for radiant heating in North America. There are several important differences between that history and use of PEX for potable water in California.

Typical radiant heating systems have a closed loop where water is heated and recirculated. Under this condition, the oxygen and chlorine originally in the water are rapidly used up and consume a proportionately small amount of the pipe's supply of antioxidant (AO). Potable water, however, continually supplies oxygen and chlorine and continually consumes AO. Using PEX radiant heating experience in Europe and North America as a proof of suitability for potable water is unwarranted. As explained below, a closed system with depleted chlorine may last 300 years; an open system with the same water and a small chlorine residual may last 10 years.

Similarly, PEX potable water use in Europe is not analogous to use in North America. Public water supplies in the U.S. are more chlorinated than in Europe and European treatment tends to use alternatives to chlorine.

> "The level of free chlorine, which is used as a disinfectant for water, is higher in the US as compared to Europe." (Long Term Durability of Cross-Linked Polyethylene Tubing Used in Chlorinated Hot Water Systems, T. S. Gill and R. J. Knapp, Wirsbo Company, Apple Valley, MN, Steven W. Bradley, Bradley Consulting Group, College Station, TX, W.L. Bradley, Texas A&M University, ANTEC 1998)

> "Ozone has been used for several decades in Europe for taste and odor control, color removal and disinfection." ... "In Europe, 50% of water distribution systems use chlorine dioxide as the residual disinfectant Source: Trussell, R., Control Strategy 1; Alternative Oxidants and Disinfectants, 1991, (Drinking Water Chlorination White Paper, A Review of Disinfection Practices and Issues, The Chlorine Chemistry Council, Arlington, VA)

Industry's failure with Polybutylene (PB) is an important object lesson.

Industry has been trying to deal with this problem and has certainly seen the risks of learning the hard way as in the case of Polybutylene (PB) pipe. Industry has tried to distance PEX from PB for marketing reasons (see e.g. Differences Between PEX and PB Piping Systems for Potable Water Applications TN-31/2004, Plastic Pipe Institute (PPI) 1825 Connecticut Ave., NW, Suite 680, Washington, DC 20009 P: 202-462-9607 F: 202-462-9779, www.plasticpipe.org), but the fact remains that PEX has the same inherent liabilities as PB. In the race to market in North America, has engineering kept up with marketing? Where is PEX on the learning curve now? What is the benefit for California to be an "early adopter" of PEX for potable water.

This letter points out several areas of unresolved liabilities for PEX mechanical failure. I preface this discussion with two observations: 1) California's delay in approving PB turned out to have saved its citizens untold headaches and saved industry millions in additional claims; prudent delay in approving PEX may have similar benefits. 2) Industry has not been candid with HCD about the nature of its product or the changes it makes as product deficiencies have arisen. HCD's present record does not show California consumers that a diligent, independent investigation has been done by HCD on their behalf.

PEX and antioxidant additives are subject to chemical attack.

PEX potable water piping will fail when the antioxidant (AO) is no longer sufficient to protect the PEX polymer itself from oxidation and consequent loss of mechanical strength. The question of mechanical failure largely hinges on the adequacy of AO protection. This means that PEX failure is not a matter of "if" – PEX always fails – rather a matter of "when." The relevant issue is thus the conditions that make premature failure more likely.

Polyolefin oxidation is mediated by free radicals generated by oxygen, other oxidizers such as chlorine in various forms, and ultraviolet light. The AO functions by trapping the free radical in a stable form that prevents attack on the PEX and stops what is usually a chain reaction. The AO has only so many active sites capable of this sacrificial function.

The first factor is the choice and amount of AO molded in when the pipe is made. Once PEX is crosslinked, it can no longer be formed as can PE, PB, PVC, or CPVC. Thus the final blend of AO must be made when the product is formed. This inherently leads to product variability: "In the past, many of the failures of plastic pipe were largely due to lack of adequate AO stabilization. Sometimes inadequate stabilization was added to the 'recipe', or sometimes the antioxidants were consumed in the extrusion process." (T Tesmar, op. cit.)

A second factor is exposure to ultraviolet light (mostly as sunlight) prior to or after installation. Ultraviolet light produces abundant free radicals and rapidly consumes AO. Even a short exposure can significantly affect PEX service life. For PEX tubing formulated with no UV barrier, it appears that a one week exposure (84 hours) is sufficient to deplete the AO present and cut the resulting pipe lifetime by a half under test

conditions (Chlorine Resistance Testing of UV Exposed Pipe", J. Couch, M. Toro, K. Oliphant and P. Vibien, Jana Laboratories Inc., Aurora, Ontario, Canada, ANTEC 2002.) PEX is frequently left exposed. I have personally observed construction sites where PEX laid under slab is pulled up for future connections and left exposed for the length of time from pipe installation, slab pour, framing, and sheathing. In tract housing this can be a month or more or exposure – that exposed segment of PEX will arguably have a far shorter life.

Alternate methods of PEX manufacture aggravate lifetime prediction.

Yet another factor to consider is the variation in PEX manufacturing, even as to crosslinking methods. Tubing sold for potable water is largely Engle or Silane crosslinked to convert starting polyethylene to PEX. As explained more later, the difference is that Engle uses peroxide compounds mixed in the pipe to initiate bonding between PE chains and Silane uses silicone bonding to link chains.

The competing manufacturers using different methods argue that their own product is superior in performance. Logically, there are likely to be different susceptibility to oxygen diffusion, loss of antioxidant during manufacture, and even oxidative resistance (chain termination). At present, I can't distinguish a preference for one method over the other. Consultant Tom Tesmar cautions "accept the fact that technology will continue to advance. As we have seen time and time before, a 'Cash Cow' can grow feathers and begin to look more like a 'Turkey'!" ("In defense of silane", op. cit.) Perhaps this is also a summary of the history of plastic pipe.

Composite PEX-AL-PEX is also subject to oxidative attack.

HCD is also considering a composite PEX-AL-PEX which is a thin walled aluminum tube with PEX on the inside and outside. At first blush, the aluminum layer strengthens the pipe and prevents diffusion of oxygen from the outside, but the interior PEX layer is still subject to oxidative degradation from chlorinated water. When the interior layer cracks, the aluminum layer is exposed to water and will itself be subject to corrosion. PEX-AL-PEX should also be subjected to real-world lifetime test conditions.

ASTM F2023 establishes standard conditions for testing PEX in chlorinated water, but does not assure in-service lifetime.

A key factor is the deliberate use of chlorine as a potable water disinfectant. The disinfection results from chlorine residual acting as a strong oxidizer in water. The role of chlorinated water in attacking polyolefin pipe has only been slowly revealed; ASTM F2023, "Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water" was only published in 2000.

This standard is a measure of resistance to oxidation – correlated with pipe lifetime, but clearly not a direct measure of lifetime. Claims of 50-year or 90-year lifetimes are all – 100% of them – based on extrapolation from short term tests. Extrapolating from a test producing failure in a few months to predict a lifetime of 50 years or more is extremely sensitive to error. [ASTM F2023-04 Section 15.1.2, Table 2: twelve pipe samples failed under standard test conditions with times ranging from 871 to 1490 hours (36 to 62 days).] Note that ASTM F2023-04 is a standard test method (how to test a product), not a material standard (product pass-fail). For obvious reasons ASTM includes a disclaimer.

> "The performance of a material or piping product under actual conditions of installation and use is dependent upon a number of factors including installation methods, use patterns, water quality, nature and magnitude of localized stresses, and other variables of an actual, operating hot-and-cold water distribution system that are not addressed in this test method. As such, the extrapolated values do not constitute a representation that a PEX tube or system with a given extrapolated time-to-failure value will perform for that period of time under actual use conditions." (ASTM F2023-04, emphasis added)

This caution is echoed elsewhere when claims of long product life are made.

> "The information in this note is offered in good faith and believed to be accurate at the time of its preparation, but is offered without any warranty, expressed or implied, including WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE." (PPI op. cit. emphasis original)

Low pH (acidic) water accelerates chlorine attack on PEX.

The ASTM standard reflects the metric Oxidation Reduction Potential (ORP) as a way of integrating water pH and chlorine concentration (Appendix X2). ORP is a measure of the overall oxidative strength of the water and is reported in units of mille volts (mV). Because chlorine acts as an acid, lower pH water (more acid) leaves a greater proportion of the chlorine present in the aggressive hypochlorous acid form:

> "At a pH of 6.5, chlorine exists almost completely as HOCl. At a pH of 8.5, approximately 90% of the HOCl is converted to the OCl-. The HOCl, considered to be a much more potent oxidizer than the OCl-(11), is believed to be the primary species responsible for chlorine induced oxidative degradation. The oxidizing aggressiveness of chlorinated potable water varies widely with pH. Testing is generally conducted at lower pH values so that the chlorine is largely present as HOCl and the water, therefore, is in a more aggressive state in terms of oxidation." (Chlorine Resistance Testing of Cross-Linked Polyethylene Piping Materials, P. Vibien, J. Couch and K. Oliphant, Jana Laboratories Inc., Aurora, ON, W. Zhou, B. Zhang and A. Chudnovsky, University of Illinois at Chicago, Chicago, IL, USA, 60607, ANTEC 2001)

"The hypochlorous acid is 80 to 300 times more oxidative than the hypochlorite ion." (The Use of Oxidation Reduction Potential (ORP) in the Testing of Plastic Pipe in Hot Water With Chlorine, Steven W. Bradley, Bradley Consulting Group, College Station, TX, Lori McPherson, George Fischer Inc., Tustin, CA, ANTEC 1998)

Ironically, low pH or slightly acid potable water is cited as a major reason to use plastic pipe rather than copper pipe. As discussed below, the effect of low pH in the normal range of drinking water may be even more significant for PEX pipe than for copper.

The effect of ORP is dramatic. Chung, et. al. exposed PEX to a range of ORP at elevated temperatures (as in ASTM F2023-04), found failure rates on a log scale, and estimated the effect of ORP on relative lifetime at a temperature corresponding to potable hot water use. In their Table 3. , Chung et. al. show a projected range of PEX service lifetimes over a factor of 229 depending on ORP. This means that the base case (slight acidity no chlorine) is predicted to last 229 times the case with slight acidity and 5 ppm Cl. The key finding is that even low chlorine levels and low pH cut PEX life roughly 30-fold.

"Table 3: Estimated Test Lifetimes at 60°C as a Function of Test Water Quality

PH	Chlorine Level (mg/L)	ORP	Relative Estimated Test Lifetime @ 60°C
6.5	5	887	1
6.5	3	873	1.2
8.5	5	778	3.7
8.5	3	758	4.6
6.5	0.1	715	7.7
6.5	0	430	229

Source: "Environmental Factors in Performance Forecasting of Plastic Piping Materials", Chung, et. al. 2003 op. cit.

Strongly oxidative conditions are found in California public water supplies.

California water supplies, particularly ground water supplies, can have strongly oxidizing conditions from low pH and high chlorine residual. Chung et. al. results show a dramatic effect at 0.1 ppm Cl, increasing as Cl concentration increases. A typical chlorine residual in the City of Sacramento, for example, is 0.5 ppm with pH averaging 7.4 (well water) or 8.5 (treated river water) (James Young, City of Sacramento, Water Quality Operations, Chemist, pers. comm. 3/25/05, Operational Statistics, Fiscal Year 2002/2003, City of Sacramento, Department of Utilities). Using the chart FIG. X2.1 Relationship of pH/Free-Chlorine to ORP in Deionized Water in ASTM F2023-04, this puts the ORP for Sacramento water at 550 mV (river) and 750 mV (wells). Typically, 18% of Sacramento water comes from wells. Moreover, many communities throughout California use wells as a primary source of drinking water.

The test conditions in ASTM F2023-04, Section 9, specify test fluid for RO or DI water (laboratory pure water) and alternately for tap water.

> "The pH and free-chlorine concentration combination shall yield a minimum ORP of 825 mV for the test fluid, see Note 5." "Tap water shall have a pH in the range from 6.5 to 8.0 and contain the necessary free-chlorine to maintain an ORP of 825 ±30 mV, see Note 5." "NOTE 5—At the time this test method was originally approved, several test laboratories had existing experimental data developed under varying test conditions, not necessarily in strict accordance with this test method.
>
> "It is suggested that future testing be conducted at conditions that are as aggressive, or more aggressive than plumbing piping might encounter in actual service; specifically, with a test fluid having a pH of 7 or lower and a free-chlorine concentration of 3 PPM or higher. Test data developed with a less aggressive test fluid having a pH higher than 7 or free-chlorine content less than 3 PPM, or both, or prepared from locally available tap-water, may provide higher extrapolated values. However, such higher values may not necessarily be representative of better performance. It is important to be aware of and consider the specific test conditions when comparing data from different materials or laboratories.
>
> "Prior data obtained with test-fluid having an ORP of 750 mV or higher still provides a conservative extrapolation for potable-water conditions found in most areas of the United States." (ASTM F2023-04)

How does Sacramento water compare with these test conditions? First off, Sacramento well water at 750 mV is around the aggressive level of "prior data" discussed in ASTM F2023-04; ASTM may consider that value to be "conservative", but is a very realistic problem for California. Second, Sacramento well water isn't far behind the current ASTM F2023-04 test-fluid 825 mV level in actual impact on PEX Estimated Relative Lifetime.

"Table 2: Relative Expected Test Lifetime at 60°C for a range of ORP's

ORP (mV)	840	825	800	775	750	500
Estimated Relative Lifetime (ERL)	1	1.2	1.6	2.2	2.9	57

Source: "Environmental Factors in Performance Forecasting of Plastic Piping Materials", Chung, et. al. 2003 op. cit.

Using data from Chung, et. al. 2003, we see that the ratio of relative lifetimes for 750 mV and 825 mV is 2.4 (2.9/1.2), meaning that the new "more aggressive" ASTM test conditions are only 2.4 times harder on extrapolated PEX lifetimes by comparison with Sacramento well water. This does not leave much of a margin for error. The data suggest that PEX in Sacramento with well water would last about one-tenth as long as PEX with river water (ERL at 550 mV is 32).

The ASTM F2023 standard is an important recognition of a serious problem with polyolefin plumbing materials. It is relatively new and its genesis reflects the evolving nature of the industry. Although ASTM F2023 addresses the key oxidation issue

(chlorine), it is still a short term laboratory test which relies on elevated temperature as a way to forecast premature failure. It does not reflect the effect of exposure to UV light or organic solvents in installation. These will reduce antioxidant concentration by degradation or accelerated leaching and presumably shorten pipe life.

Mechanical failure has economic, public health, and environmental impacts.

PEX is subject to several modes of failure, described in ASTM F2023 and other sources. The particular concern is for "environmental or oxidative failure (Stage III), n—failure in the tubing wall characterized by a large number of cracks emanating from the interior surface of the tubing wall ..." In service, this failure mode usually produces catastrophic failure leading to water damage, possible black mold, and at least temporarily rendering the dwelling uninhabitable. The serous impact of failure on the California consumer warrants a close look by HCD based on independent review of the proposed products.

Conclusion regarding Mechanical Failure.

The antioxidant in PEX pipe is like a burning fuse to PEX failure. The amount of antioxidant in place when the pipe is made effectively determines length of the fuse; the oxidative environment acts like wind blowing on the flame, speeding the burning fuse. Pre-installation exposure to UV light shortens the fuse. High chlorine, high temperature, high dissolved oxygen, or low pH all burn the fuse faster. All PEX will fail, it is only a question of when. All current North American PEX installations are like a bunch of bombs with burning fuses -- we just can't see how long they have to go.

Only recently have we begun to see how dramatically these environmental conditions affect pipe lifetime. Only recently has there been a standard test, but ASTM warns, " ... extrapolated values do not constitute a representation that a PEX tube or system with a given extrapolated time-to-failure value will perform for that period of time under actual use conditions."

So far, HCD has not made even a half-hearted attempt to gather relevant information. HCD has not placed an obligation of disclosure on all PEX manufacturers that will be marketing in California. Despite product improvement and industry optimism, there is a need for HCD to consider how PEX should be used in California and under what conditions to mitigate potential for mechanical failure and consequent impact on the consumer.

3. Potential Adverse Health Issues

The Housing and Community Development "Literature Search Concerning on (sic) the Use of PEX as Potable Water Pipe" purports to rebut several public health concerns raised by my earlier letters. Oddly, most of the Literature Search rebuttals are to statements I never made. It seems that HCD tries to set up straw men that would be easier to knock down or perhaps the persons preparing the Literature Search did not have

access to the actual text of my letters. This illustrates the consistent flaw in HCD's decision making process: lack of insightful and independent analysis.

HCD has squandered an opportunity to ask PEX manufacturers for information and thus to inform the California consumer. The Literature Search is based on a series of email and correspondence between Bill Staack at HCD and representatives of Uponor Wirsbo (a PEX manufacturer) and NSF International. HCD does not receive a complete reply to its questions and lets the matter slip.

The Arizona PEX lawsuit raised issues that HCD has not addressed.

Defren v. Trimark, an Arizona lawsuit in 2002 revolved around a PEX potable water installation. Uponor Wirsbo, the PEX manufacturer, was involved as a third party defendant. The home owner sued the home builder claiming among other things that "Plaintiff and her teenage daughter have been diagnosed with chemical poisoning and have been directed by their joint physician to vacate the house" (Defren v. Trimark, Complaint, p2 item 11). In the course of its defense, Wirsbo disclosed information to the court in Arizona that has apparently not been subject to further review by HCD.

I describe the significance of this disclosure in my January 13, 2003 and April 14, 2003 letters. The disclosure sheds light on the problem of chemical leaching from PEX pipe and permeation of PEX pipe by chemicals in the surrounding environment.

HCD has not followed up on the new information provided to it. The full extent of inquiry is an email from Mr. Staack to Rich Houle, Uponor Wirsbo Director of Codes and Standards asking for comment on a supposed statement of mine regarding "poisoning" in the Defren v. Trimark case (I did not use this phrase in my letters). In response September 11, 2003, Mr. Houle incorrectly states that the litigation did not involve poisoning, when in fact that was the major claim by the plaintiff. Mr. Houle did not comment on the levels of MTBE Wirsbo knows to leach from the pipe, saying only that the water in question in litigation "meets all state and federal guidelines for safe drinking water". Not true in California.

Engle method PEX-A contains reaction byproducts that will leach into drinking water.

The Engle method involves extruding the pipe resin with a peroxide catalyst and other additives which leaves chemical fragments in the completed pipe. Uponor Wirsbo is the manufacturer of AQUAPEX and is one of the largest North American PEX distributors. AQUAPEX is made from PEX-A, cross linked polyethylene manufactured through the Engle method.

The chief chemicals expected to leach from PEX-A are Methyl-tert-Butyl ether (MTBE), tert-Butyl alcohol (TBA), and various benzene-type or phenolic aromatic hydrocarbons which may be fragments of antioxidant additives. This material will leach from PEX-A or PEX-AL-PEX pipe made with PEX-A.

Wirsbo refused to disclose to HCD what levels of these compounds may be present. As reported previously, in Defren v. Trimark, Wirsbo's own tests showed high levels of these compounds and NSF International disclosed at lease some similar results. In response to HCD query, Dave Perkiss, NSF International, did not comment on my report that NSF Tests on PEX leachates had observed MTBE with normalized concentrations of 15, 17, 22 ppb, but merely asserted that NSF results for PEX-A are below its 50 ppb health effects level (Dave Perkiss, email to Bill Staack sent Sept.. 15, 2003). Presumably, NSF International routinely approves pipe with levels of MTBE up to 50 ppb.

The NSF results are normally kept secret, considered the property of the manufacturer. The few results we have were disclosed by Uponor Wirsbo in defense of litigation. For this reason, we can't see the full extent of MBTE and TBA leaching.

European studies of several plastic pipes similarly concluded that PEX may leach MTBE and other VOCs in significant amounts. One study found that "VOCs leaching from PEX pipes gave an intense odour of test water. Several of the migrated VOCs were not identified. Oxygenates predominated within the identified VOC with methyl tert-butyl ether (MTBE) as a major component." (Potential water quality deterioration of drinking water caused by leakage of organic compounds from materials in contact with the water, Lars J. Hem, Aquateam AS, P O Box 6875 Rodeløkka, 0504 Oslo, Norway, E and Ingun Skjevrak, Regional Food Control Authority, Stavanger, Norway)

Hem, et. al. concluded "According to the EU council directive, the drinking water shall have a taste and odour acceptable to consumers, and there shall not be any abnormal change in the taste (EU, 1998). This means that when organic compounds from materials in contact with the water leach VOCs in an amount that gives unacceptable taste and odour to the water, this is in conflict with the EU council directive. ... VOCs from PEX pipes in in-house installations may also be present to an extent that is in conflict with the directive. " (op. cit.)

Another European study by some of the same authors reiterated these conclusions and reported that MTBE leached from some PEX pipes in concentrations as high as 47.6 ppb. (Skjevrak, et al, Volatile Organic Components Migrating from Plastic Pipes (HDPE, PEX and PVC) into Drinking Water, Water Research 37 (2003), pp. 1912-1920.)

The few tests released by NSF International have also confirmed the MTBE and NSF may leach in significant amounts. For example, a July 3, 2000 NSF test of Wirsbo AQUAPEX, found this particular pipe to leach MTBE in a normalized concentration of 17 ppb and to leach TBA (identified in the test as 2-Methyl-2-Proponol – another name for TBA) in a normalized concentration of 6900 ppb.

HCD ignores the significance of the acknowledged leaching.

PEX-A based potable water systems will likely deliver MTBE levels in the range of 5 to 50 ppb depending on standing time, for the first half year of use or possibly longer. HCD dismisses a PEX-A leaching concern, apparently buying in to the manufacturer's and NSF claim that the lower US EPA action level (20 ppb) is based on taste and odor and hence of no regulatory or public decision-making significance. The industry thinking being that "as long as it is not a strong poison, it is O.K".

It is preposterous for a state agency, HCD to take this approach. Commonly installed PEX-A is known to leach MTBE and TBA at levels well above the state's own public health guidelines and above the state and the US EPA levels for protection of consumer taste and odor.

For MTBE: The California Office of Environmental Health Hazard Assessment ("OEHHA") has adopted a public health goal (PHG) for MTBE of 13 ppb for drinking water. "A Public Health Goal (PHG) of 0.013 mg/L (13 ug/L or 13 ppb) is adopted for methyl tertiary butyl ether (MTBE) in drinking water. The PHG is based on carcinogenic effects observed in experimental animals." (Public Health Goal for Methyl Tertiary Butyl Ether (MTBE) in Drinking Water, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Pesticide and Environmental Toxicology Section, Anna M. Fan, Ph.D., Chief Deputy Director for Scientific Affairs, George V. Alexeeff, Ph.D., March 1999). The California Department of Health Services (DHS) has similarly set a health-based Maximum Contaminant Level (MCL) on MTBE of 13 ppb. DHS has also set a secondary MCL on MTBE of 5 ppb for taste and odor.

For TBA: The state establishes an action level of 12 ppb and offers public water suppliers the optional health effects language for customers, "Some people who use water containing tert-butyl alcohol in excess of the action level over many years may have an increased risk of getting cancer, based on studies in laboratory animals." (Appendix A-3: State Regulated Contaminants with No MCLs i.e., "Unregulated Contaminants" Monitoring required by Section 64450, Chapter 15, Title 22, California Code of Regulations.)

The public health guidelines, MCLs and action levels represent the state's considered efforts to protect consumers. It makes no sense whatsoever, for a state agency to cavalierly disregard the protective guidelines and allow deliberate installation of a product that exceeds levels the state has set to protect health or that the state and US EPA have set to protect taste and odor.

Organic chemical leaching from PEX may have a cumulative effect.

MTBE is found in many water supply systems. This is the main reason MTBE was discontinued as a gasoline oxygenate additive: it migrates rapidly when released into the ground water environment and it is difficult to remove from the water. Indeed, Rich Houle, Wirsbo Director of Codes and Standards, states that "published records from the City of Scottsdale [AZ] regarding its water supply acknowledged the presence of MTBE in wells serving the Scottsdale area" (Houle, op. cit.).

California has set a primary MCL of 13 µg/L (2000) that addresses health concerns and its public health goal is also 13 µg/L, sets a secondary MCL of 5 µg/L (1999) that addresses taste and odor concerns, and sets detection limit for purposes of reporting (DLR) of 3 µg/L. The DLR is the level at which DHS is confident about the quantity being reported. Results at or above the DLR are required to be reported to DHS; some laboratories may report results at lower concentrations. (http://www.dhs.ca.gov/ps/ddwem/ chemicals/MTBE/mtbeindex.htm)

As of May 2, 2005, the DHS database of MTBE monitoring results identified 109 public drinking water systems with consistent MTBE detections. In 28% of these systems MTBE was found in concentrations above the public health goal; in 53% of these systems MTBE was found in concentrations above the taste and odor MCL. Counties found to exceed the public health MCL include Los Angeles, San Diego, Kern, Monterey, San Francisco, Riverside, Sacramento, El Dorado, Orange, Yuba, Madera, San Benito, and Siskiyou. (DHS MTBE Monitoring results, Update: June 9, 2005)

MTBE contamination potentially affects a substantial population. MTBE is the major component of Reformulated Gasoline, which was required for major urban areas. The US EPA states, "Due to its widespread use, reports of MTBE detections in the nation's ground and surface water supplies are increasing." In California, MTBE has been found in more than half of the reservoirs and has caused water supply curtailment in Santa Monica, South Lake Tahoe, Santa Clara County and Sacramento.

HCD needs to consider the cumulative effect of even low levels of MTBE leaching from PEX combined with the levels already found in drinking water. For the roughly half of samples with detections, the PEX pipe need contribute only from 1 to 8 µg/L to bring water from the taste and odor threshold to the public health threshold. MTBE permeation from PEX exposure to contaminated water is another cumulative source. Will HCD disapprove the use of PEX in areas where water supplies are already known to be or may potentially be contaminated with MTBE?

PEX permeability is an acknowledged industry problem.

Polyethylene permeability is a major limitation to its use for food packaging and other applications where oxygen and water vapor need to be excluded. One approach in packaging is to add a second layer of a less permeable plastic. PEX manufacturers are adopting this approach to limit oxygen diffusion in PEX tubing for use in radiant heating. Although the focus is primarily on keeping oxygen levels low in closed loop systems, the results indicate the permeation potential for PEX potable water supply pipe.

> "In recent years it has been discovered in Europe, after enormous corrosion and subsequent sludging problems developed in systems utilizing oxygen permeable plastic tubing in "closed systems", that plastic tubing allowed enough oxygen permeation through the pipe wall to cause corrosion in the system."

"The German Industry standards (DIN) have determined that an oxygen diffusion rate of 0.1 mg/liter/day or less at a water temperature of 104 degree F. (40 degree C.) in plastic tubing is considered a safe level to prevent oxygen corrosion in heating system components. For comparison: The amount of 5 milligrams of oxygen per liter per day caused by oxygen diffusion through the pipe wall is equivalent to completely draining the heating system and refilling it with fresh water every other day during the heating season." (Metal-plastic multilayer pipe having form stability for plumbing and hydronic heating, US Patent 20020007861).

Oxygen PEX diffusion in ordinary potable water pipes may be on the order of several mg O2/liter void volume per day. Disregarding chemical interactions, the rate of diffusion is roughly proportional to the inverse square root of the molecular weight. Based on similar polarity to PEX, benzene would move at 64% of the rate of oxygen. Alkyl substituted benzenes (e.g tetra methyl benzene) would move at 45% of the rate of oxygen. This suggests that a PEX tube exposed to a 0.2% benzene concentration in a termiticide or in gasoline, would produce benzene in drinking water at around 10 ppb after standing overnight, and upwards of 100 ppb standing for a week. This result is in line with the lab tests from the Arizona litigation which found alkyl substituted benzenes at roughly 70 to 220 ppb. Because the reservoir of chemical in the environment is so large, permeation is expected to continue for many years and hence is a long tem exposure.

Comparing permeation potential for benzene in this range, PEX in contaminated ground may easily exceed the state MCL of 1 ppb or the US EPA MCL of 5 ppb.

PEX is permeable to chemicals in the environment.

Permeation is the phenomenon where relatively low molecular weight substances migrate through a seemingly solid polymer barrier. Permeation is a concern where the ground and groundwater are contaminated with petroleum compounds, with the gasoline additive MTBE, or with pesticides, particularly termiticides. Although most domestic plumbing will be within the structure itself, the approval considered by HCD includes external exposure from the water metered to the structure or under slab for slab on grade home construction.

"Permeation may do little if any harm to the material, but it may have application-related effects. The permeating chemical may transfer into a fluid on the other side of the pipe. In general, thermoplastic pipes should not be used where a permeating chemical could compromise the purity of a fluid such as potable water inside the pipe ..." (Thermoplastic Piping For The Transport Of Chemicals, January 2000) Although technically no longer thermoplastic after crosslinking, PEX is included in the cited discussion.

The PEX Industry acknowledges the limitation and warns "Do not allow tubing to come in extended contact with any of at least the commonly encountered construction materials listed below: (This list is not all-inclusive.) Pipe thread sealing compounds; Fire wall penetration sealing compounds. Exception: water soluble, gypsum-based caulking;

Petroleum-based materials such as: Kerosene Benzene Gasoline, Solvents, Fuel Oils, Cutting Oils, Asphaltic Paint, and Asphaltic Road Materials." and "Do not place any PEX tubing in heavily contaminated soils or other heavily contaminated environments." (The Plastic Pipe and Fittings Association, 2002 Installation Handbook: Cross-linked Polyethylene (PEX) Hot and Cold Water- Distribution Systems, page 4.)

PEX is permeable. PEX manufacturer Uponor Wirsbo says so: "The permeable characteristics of cross-linked polyethylene tubing prohibit installation in soil or ground water contaminated with solvents, fuels, organic compounds or other detrimental materials. Where such conditions are suspected, chemical analysis of the soil or ground water should be performed before installation". (Defren v. Trimark, Wirsbo disclosure statement, page 3.) Will HCD require such testing in California for PEX under slab installation?

4. Potential Fire Hazard Issues

The substitution of a plastic product for a metal product poses the obvious concern for fire safety. The plastic pipe carrying water is not likely to be flammable, but exposed to heat in a fire, the plastic pipe will rapidly rupture, draining or de-pressurizing the system and creating openings in wall studs which may encourage fire spread.

The Model code attempts to address some of these concerns by requiring fire stopping at pipe penetrations. It would be appropriate for HCD to seek comment by California fire officials on the likely efficacy of these fire prevention mechanisms, particularly in light of the high seismic activity and associated risk of structure fire in most of the state. Options for fire stopping materials for PEX are limited because many types of fire stopping materials are incompatible with PEX, will void the manufacturer's warranty, and may cause premature failure. Will HCD identify which fire stopping materials are appropriate for use with PEX and certify those as adequate to protect the public from fire risk?.

5. Potential Solid Waste Impacts

Solid Waste Management is important to California. Construction waste and demolition debris are a major portion of the waste stream and much effort has been made in the past decade to increase the amount of construction materials that can be recycled and diverted from the landfill. While Copper piping is eminently recyclable, there is currently no recycle market for PEX. Due to the crosslinking manufacturing step, PEX cannot be remelted like ordinary polyethylene and is inherently unsuited for reuse and virtually impossible to recycle.

The Commission should consider the impact that replacing a recyclable building product with a non-recyclable product may have on the increasing solid waste disposal problem facing the state.

* * *

In conclusion, we have been trying to get HCD to consider important information on public health and consumer protection. The level of documentation reflected by the "Literature Search" does not meet the usual standards of independent review and public disclosure that would be required for a state agency making an important decision.

Sincerely,

Thomas S. Reid

GT ENGINEERING

June 29, 2005
05-019.RC

California Building Standards Commission
915 Capitol Mall, Suite 200
Sacramento, CA 95814

RE: Use of PEX for potable water plumbing

Chair and Members of the Commission:

At the behest of the California Pipe Trades Council, I have been requested to submit this letter regarding my experience with failures in cross-linked polyethylene (PEX) piping. By way of personal background, my education includes a Ph.D. from the University of California at Berkeley in Materials Science and Engineering. For the past 28 years I have been continuously employed in materials research and failure analysis. Since 1988 my work has concentrated on forensic analysis of materials failures, serving as an expert consultant to manufacturers, industry, the Federal Government and the insurance industry. On numerous occasions I have been retained by legal counsel and have provided expert testimony on issues involving degradation and/or failure of materials. Many of these cases have involved failures in polymers and plastics and specifically PEX piping.

In this letter I address my personal experience with massive failures of PEX piping that has been the subject of numerous lawsuits in Washington State and is a matter currently the subject of efforts to establish a class action against the manufacturer. It is my belief that while the Washington State failures involve a single manufacturer, the issues revealed as a result of these losses are not solely limited to the batch of pipe involved in these failures. These failures demonstrate that PEX pipe may potentially prematurely fail if exposed to a number of commonly encountered materials and environmental conditions, including chlorine, sunlight, metal ions, high temperatures and solvents including those in some firestopping material. Further study of the sensitivity of PEX to failing when exposed to these materials and conditions should be considered in order that appropriate mitigations and limitation on the use of this product may be imposed.

PEX is a generic label applying to a whole range of PEX pipes, accordingly the sensitivity of PEX pipe to these materials and conditions may vary widely depending on the manufacturing process and the stabilizing additives added. While improvements to this product are continually being implemented, the State of California is contemplating generic approval of PEX, rather than approval of a specific version of PEX. While NSF and ASTM standards provide some assurance of quality, these standards do not eliminate the possibility of premature failures. These industry standards are limited in scope and do not fully reflect real life applications.

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Response to HCD Literature Search

First, allow me to comment on the "HCD Literature Search Concerning on the Use of PEX as Potable Water Pipe" dated February, 2004. In my opinion there are a number of shortcomings and errors in this document.

In section A1 there is an attempt to distance PEX from historical polybutylene (PB) failures. Both of these materials belong to the same plastic family, referred to as polyolefins. In addition polypropylene (PP) is another polyolefin. Many are familiar with the widespread failures and subsequent litigation involving PB. The massive failure of PP water heater dip tubes was also the subject of a nation-wide recall a couple years ago, with on-going litigation between the water heater manufacturers and the supplier of the dip tubes. I am an expert consultant involved in this litigation. The fact is that all polyolefins are inherently unstable in heated water and require the presence of stabilizing additives to maintain long term integrity. The issues in PEX, PB and PP potable water piping applications are all similar, loss or consumption of the stabilizer package leads to failure of the piping.

In section A2 it is stated that PEX is not subject to attack by chlorine in water. This is simply incorrect. Chlorine is a strong oxidizer. Its presence in most domestic potable water causes the oxidative loss of stabilizers in the PEX which, upon depletion, leads to relatively short term degradation of the PEX molecular matrix and pipe failure. This is why a new stronger standard has been enacted (ASTM F 2023-04) in an attempt to alleviate the issue of chlorine-induced failures in PEX piping. This standard, however, only addresses the singular issue of pipe longevity under the specific test protocol. PEX pipe meeting the new chlorine standard may still fail due to chlorine exposure where it has also suffered significant stabilizer loss due to other factors.

In section A4 there is reference to a law suit involving PEX failures in a condominium complex in Seattle. The statement "only 19 of the 57 units experience (sic) water damage do (sic) to the PEX mechanical failures" is ludicrous as well as entirely misleading. First, this represents a 33% failure rate, which no one could conceivably believe is acceptable. Second, as provided in detail below, all of the tubing from the same PEX resin in these residences was highly deteriorated and would shortly have failed. More didn't fail because the residents shut down and isolated their hydronic heating systems until the piping was replaced. I know this for a fact because my laboratory tested piping samples from throughout the condominium complex.

Massive Failures in PEX Tubing

There have been, or are about to be, massive failures in PEX piping. In Washington State, I have been personally involved in the analysis of PEX piping that is failing in 9 multifamily residential complexes (condominiums, town homes and apartments). These complexes currently account for over 200 residential units. Through discovery in the litigation involving these failures I have become aware of similar failures in Canada, though my company has not independently evaluated the causes of the Canadian failures.

The above failures all involve piping manufactured by a single vendor, Plasco Manufacturing, Ltd. (Plasco), labeled as UltraPEX™ and identified as Lot 7. Lot 7 means that the tubing originated from a single resin source, Flexet™ 5100 resin/Flexet™ 725 catalyst that was originally distributed by AT Plastics Inc, which was subsequently purchased by Noveon. UltraPEX is PEXb produced by the silane cross-linking process. It is my understanding that there are several additional PEXb manufacturers that were or are using the same resin. There were millions of feet of Lot 7 UltraPEX distributed throughout the United States.

The Washington State failures have all occurred in open loop hydronic heating systems, with failures starting as soon as 2 to 3 heating seasons. The susceptibility of PEX pipe to failure, however, is not limited to open loop hydronic systems. Failures in at least one of the Canadian locations were occurring in hot potable water lines.

UltraPEX tubing was warranted by the manufacturer for 25 years. Plasco was purchased by Uponor (also owner of Wirsbo) in 1998. Recently Wirsbo shut down both its Plasco and RTI PEXb piping operations.

Time to Failure

The Commission's evaluation of the potential impacts of PEX should include consideration of the material's longevity in actual allowed service, as well as what happens upon failure.

Such evaluation must go beyond mere compliance with ASTM and NSF requirements. Our laboratory studies, for example, demonstrated that UltraPEX Lot 7 pipe under near ideal conditions for open-loop hydronic heating would be depleted of all failure inhibiting stabilizer in 8 to 10 years. This product was produced from 1996 to 1999. The product was also listed as conforming to the requirements of ASTM F876[1], the primary standard for PEX tubing, ASTM F877[2] and being in conformance with NSF requirements for potable water application NSF-pw (NSF 14[3] and 61[4]) at the time of manufacture. The failure of the UltraPEX pipe demonstrates that conformance with ASTM and NSF standards does not, in itself, guarantee that this material will not prematurely fail in a manufacturer allowed application.

The potential scope of damage from PEX failures must also be assessed. PEX failures may be more likely than copper pipe failures to cause catastrophic damage. One of the problems with PEX is that the material embrittles; failure, thus, typically results in a large catastrophic break. My experience with copper piping is that corrosive failure generally

[1] ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing
[2] ASTM F877 Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
[3] ANSI/NSF 14 Plastics Piping System Components and Related Materials
[4] ANSI/NSF 61 Drinking Water system Components – Health Effects

leads to localized penetration that provides a limited volume leak through a pin hole or small crack.

Sensitivity to Firestopping Material

Initial failures of UltraPEX piping in the Washington State cases were noted where intumescent firestop material was in contact with the pipe. The Plasco installation instructions of the period did not forbid the use of the firestop and the firestop material was specifically labeled as safe for use with PEX pipe. Our analysis showed that pipe under the firestop material was completely depleted of stabilizers, as determined by oxidation induction time (OIT) testing per ASTM D3895[5]. Fourier Transform Infrared (FTIR) spectroscopy showed that only traces of a solvent from the firestop could be identified penetrating the PEX. However, this was apparently sufficient to degrade the pipe. The pipe had turned yellow and become embrittled resulting in axial and circumferential cracking. When OIT tests were conducted in piping away from the firestop region it was discovered that the stabilizer package in the material had been substantially depleted throughout the pipe.

It should be noted that while exposure to firestopping accelerated the failure of the PEX piping, it was not the sole cause for degradation of the piping. Similar findings were found in each of the complexes using the Plasco Lot 7 pipe, even in those complexes where firestop was not employed. Thus, I believe we are witnessing the tip of the iceberg as far as failures are concerned, discovered incidentally because of the application of a particular firestop material.

PEX Sensitivity to UV Light

Our own experiments showed that Plasco UltraPEX tubing was virtually devoid of residual effective stabilizer after two weeks of rooftop exposure in sunny Seattle. This contradicted implications in the product literature that with exposure of no more than 30 days the product should have been serviceable for the 25-year warranty period.

It is my experience that several PEX piping producers have instituted improvements in packaging because of sensitivity to UV degradation of their product. While this may address transportation and storage exposure it does not provide assurance that product is protected at the jobsite. Furthermore, such UV protective packaging is not required by ASTM or NSF.

Literature from PEX piping producers warns against UV exposure, but I have never seen any data that quantifies exposure to the loss of product longevity. I believe this would be important information to have in assessing the permitted application of PEX piping, since my experimental observation is that upward of 7 to 8% of product life may be lost per day of exposure.

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[5] ASTM D3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.

Defense Positions

Statements by Plasco's key employees, including their director of quality of control, were that the product was made in accordance with the applicable standards, implying this made the material serviceable. An important point was that no one at Plasco actually knew anything about the material. The tubing manufacturer had no information on the stabilizer package in the Flexet resin/catalyst, hence in the UltraPEX tubing being manufactured from the resin. Further, the manufacturer had conducted no independent service testing of their product, aside from the standards compliance testing.

There had been numerous early failures, prior to the mass failures in Washington State. These had all been attributed to ultraviolet (UV) light exposure, allegedly at the responsibility of the purchaser. While UV light may lead to failure of PEX piping, our assessment of post-failure analysis conducted at the manufacturer showed that there was no validity in their testing for isolating UV damage versus other mechanisms leading to embrittlement.

Legal defense in the Washington State cases has concentrated on issues with the design and installation of the affected hydronic heating systems, and piping product compliance with regulatory standards. I will address standards compliance testing in the next section. The hydronic heating systems at issue were all of open loop design. In this design heating water is intermixed with potable water in a common domestic water heater or boiler. Thus, the heating system PEX pipe is continuously exposed to refreshed oxygenated and chlorinated water, same as occurs in potable water systems. This is an allowed, even promoted, design in Plasco literature. The defense indicates this allowed use promotes degradation through exposure to oxidizers; time of exposure and temperature are also factors.

Other issues brought up in defense are exposure to ferrous metals and/or mixed metals in the piping systems attached to the PEX tubing. They argue that metal ions of copper and iron promote oxidation of the PEX. Surely the Commission should recognize that potable water for domestic consumption will be oxygenated, will most likely contain chlorine, and will be subject to the presence of metal ions both from the water sources and from water transmission systems. This admission raises a fair argument that installation of PEX piping in a remodel or repair to a residence with copper or iron pipes may contribute to premature failure of the PEX pipe. The Commission should question the PEX piping industry regarding data on the sensitivity to PEX degradation in the presence of metal ions and corrosion product.

Standards Conformance and Testing – What Does it Mean

ASTM F 876[6] is the primary standard addressing PEX tubing. This standard was first published in 1984. There have been 23 versions of the standard including the current issuance. Only starting in the 2002 version was chlorine resistance testing mandated. It

[6] ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing

is obvious that the PEX standard has been highly evolutionary, addressing issues, such as failures in chlorinated water, as they have arisen. ASTM F 876 references into PPI TR-3[7] for hydrostatic design stresses. PPI TR-3 then references into ASTM D2837[8] for the test method to obtain an extrapolated 100,000 hour (11.4 year) design life. This whole procedure utilizes accelerated methods (elevated temperature and pressure) to obtain extrapolated lifetimes.

The methodology inherently assumes that the properties of the piping material do not change over time. However, with materials such as PEX, extended service lifetimes depend on the continued availability of the stabilizer package.

The most extensive research conducted on polyolefins, including PEX, was a long-term program at Studsvik AB, Sweden. This work showed that the stabilizers are subject to both consumption and loss due to leaching from the pipe, both internally and externally.[9] Thus, conformance to standards based on accelerated testing does not guarantee viability under extended service usage.

More stringent testing, such as ASTM F-2023-04[10] has only recently been developed to address obvious problems with failures in chlorinated water. This standard seeks to provide assurance of a 50-year lifetime. However, similar to other test standards this one contains the following caveat:

> "The performance of a material or piping product under actual conditions of installation and use is dependent upon a number of factors including installation methods, use patterns, water quality, nature and magnitude of localized stresses, and other variables of an actual, operating hot-and-cold water distribution system that are not addressed in this test method. As such, the extrapolated values do not constitute a representation that a PEX tube or system with a given extrapolated time-to-failure value will perform for that period of time under actual use conditions."

One should also note that ASTM F-2023-04 only provides a PEX lifetime assessment for water disinfectant systems using free-chlorine. Note 1 in the standard states "Disinfecting systems other than chlorine have not been evaluated by this method." The other methods mentioned include chlorine dioxide, ozone, and chloramines.

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[7] PPI Technical Report TR-3/92 Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

[8] ASTM D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastics Pipe Materials

[9] Smith, G.D. et al, Modeling of Antioxidant Loss From Polyolefins in Hot-Water Applications. I: Model and Application to Medium Density Polyethylene Pipes. Polymer Engineering and Science, May 1992, V.32, No. 10 p. 658

[10] ASTM F-2023-04 Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water

Based on the above, as well as our direct experience with PEX piping, it becomes obvious that manufacturing to existing codes and standards provides only limited information on the relative serviceability of the product under the chosen test conditions. Importantly, there do not currently appear to be standards or tests that address the effects of the multitude of environmental contaminants or challenges that may affect the PEX product from the outside. For example, should there be some minimum longevity to UV exposure? The UltraPEX pipe we tested was very sensitive to permeation and loss of integrity in the presence of minute amounts of organic solvents. Many household products, for example pesticide sprays, may have an organic carrying agent. For a potable water application it would appear reasonable to understand and regulate the permeability as well as continued integrity of piping to potentially hazardous environmental conditions.

Furthermore, NSF and ASTM standards do not address the cumulative effects of exposure to environmental conditions and contaminants that may affect the longevity of PEX. For example, our tests have shown that just a few days of exposure to the sun may dramatically reduce the amount of the antioxidants available to protect PEX pipe from expected exposure to chlorine.

Alternative Forms of PEX Piping

Another form of PEX piping is the PEX-AL-PEX configuration. This design has a thin layer of aluminum (Al) sandwiched between inner and outer layers of PEX. The PEX on this composite material may be subject to the same degradation issues as the singular PEX piping. The thin Al layer serves as a diffusion barrier and would provide structural reinforcement. I am not personally aware of whether this particular product has UV protection in the outer PEX layer, though the Al layer will limit the depth of degradation. Further study or disclosure by the manufacturer is needed to assess the mechanical stability of PEX-AL-PEX when its PEX layers become devoid of stabilizer and embrittle.

Significance to California Building Standards

I believe that the above information presents a fair argument that PEX piping may be susceptible to premature failure even when it complies with minimum NSF and ASTM standards. This potential for failure is significant and should be considered by the California Building Standards Commission in their deliberations concerning application of PEX piping for several reasons:

1. There are significant numbers of failures of PEX material in potable hot water applications. Through a set of circumstances that led to particularly early failures in a number of Washington State residences, we were led to the early discovery of what I believe will almost certainly become a massive loss of serviceability of PEX pipe. While the losses we are knowledgeable about trace to a single manufacturer, there apparently were multiple manufacturers of PEX pipe that are using the same resin.

2. Furthermore, the failures have revealed weaknesses in PEX generally that may not be limited to just this particular resin. These failures demonstrate that PEX pipe may potentially prematurely fail if exposed to a number of commonly encountered materials and environmental conditions, including chlorine, sunlight, metal ions, high temperatures, petroleum products and firestopping material. Further study of the sensitivity of PEX to failing when exposed to these materials and conditions should be considered in order that appropriate mitigations and limitation on the use of this product may be imposed.

3. A manufacturer's claim that piping is manufactured to be compliant with all the applicable ASTM and NSF standards is insufficient to assure long-term serviceability. This is true for service under intended exposure environments. There is no testing under the applicable standards to which PEX pipe is certified that assures serviceability and safety under conditions of unintended or credible accidental exposure.

4. At least some PEX pipe manufacturers have no inherent knowledge of the properties or resistance of their product. These manufacturers totally rely on the information imparted to them by their resin suppliers. The information provided by the resin suppliers, even through numerous routes of legal discovery, has been very limited and does not typically include quantitative test data to support safety evaluations of the product in an adverse environment.

5. PEX piping is not a single, uniform, product. There are undoubtedly some superior performing products along with those that likely will not provide a serviceable product for a reasonable structural life expectancy. The foremost problem facing the user, and the regulator, is the lack of access to data that provides a basis for decisions on individual product adequacy. Unlike a material such as copper pipe, where conformance to ASTM specifications does denote a consistency in product performance, the performance of PEX piping is not an inherent feature of the material. Rather it depends on the stabilizers, the types, amounts, and relative amounts, which are added to maintain the integrity of the structural backbone of the plastic. The design of particular stabilizer packages are considered highly proprietary and often rests not with the pipe manufacturer but with those companies formulating the resins used in the extrusion of PEX piping.

6. There should be concern about the inherent weaknesses of some PEX products. The material is inherently subject to diffusion of classes of chemicals that may prove injurious should they reach potable water service. Much of the material currently in service has not been UV stabilized, therefore suffers from performance loss subject to the vagueness of construction site protection. There are methods, both in terms of physical design and the addition of diffusion barriers, that may preclude problems, but these are not necessarily present in the broad definition of PEX piping that meets current standards. Based on my experience, many PEX piping manufacturers will not be able to provide data on the behavior of their product under conditions of exposure that regulators should consider for safety of the public water supply, such as when pesticides are applied where they may come in contact with residential piping.

Before the California Building Standards Commission approves application of PEX for potable water systems it would appear prudent that further assessment be conducted. In my opinion the process needs to include a definition of hazards, determination of appropriate testing that will assure adequate resistance to identified hazards, and definition of what information manufacturers and suppliers need to develop to assure an adequately safe and serviceable product.

Sincerely,
GT ENGINEERING
(A Subsidiary of GlobalTox, Inc.)

Robert A. Clark, Ph.D.
Principal – Materials Scientist

GT ENGINEERING

June 28, 2005
05-023.RC

California Building Standards Commission
915 Capitol Mall, Suite 200
Sacramento, CA 95814

RE: Use of PEX for potable water plumbing

Chair and Members of the Commission:

At the behest of the California Pipe Trades Council, I have been requested to submit this letter regarding potential biological issues with use of cross-linked polyethylene (PEX) piping. It is my understanding that the Commission is considering authorization of wider application of PEX piping in potable water applications. Based on my own personal testing, along with review of pertinent literature, the following thoughts and opinions are provided for consideration during your review process.

My professional background since 1988 has been as a consultant dealing with forensic analysis of materials failures and engineered systems, serving as an expert consultant to manufacturers, industry, the Federal Government and the insurance industry. On numerous occasions I have been retained by legal counsel and have provided expert testimony on issues involving degradation and/or failure of materials. A pertinent part of my experience is in dealing with corrosion and water chemistry. From 1976 to 1985 I held progressive scientific posts at Battelle Pacific Northwest Laboratory, eventually becoming a staff scientist and then manager of the Corrosion Research and Engineering Section. I am currently a founding principal with GlobalTox/GT Engineering. The company has two areas of focus. GlobalTox staff includes toxicologists, certified industrial hygienists, and pharmacology. GT Engineering staff deal with hard sciences including metallurgy, materials science (plastics/polymers), chemistry and mechanical engineering. Together we address the range of human exposure along with the engineering side of how the exposures develop. For example, from friction surfaces such as brakes to asbestos exposure, from batteries to gaseous emissions, and from piping systems to bacterial exposure. Current projects include spread of Legionella in the water systems of a high rise complex and exposure to bacterial growth in open loop hydronic heating systems piped with cross-linked polyethylene (PEX).

My personal concern with biological growth in PEX piping stems from numerous litigation cases over the last two years involving PEX piping failures in Washington State. I was retained by counsel for homeowners associations in these cases. Initially the issue was failures of the PEX piping in hydronic heating systems, leading to property damage. Our evaluations of the heating systems determined that there were also potential biological issues. This was first evident with the observation of biofilms found in the heating system pipes. Attachment 1 is a picture of a water sample drawn from a hydronic

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heating loop. The heating systems utilized an open loop design, meaning that the water from the hydronic heating system is supplied by and returned to the potable water in the domestic water heater. Biofilms formed despite the system design which allows for refreshing the chlorine content in contact with the piping. Water samples were acquired from three condominium complexes. Sampling strategy was based on having a 95% probability of drawing at least one infected sample assuming a 10% infection rate. Analysis was conducted for the presence of a broad range of bacteria, rather than for a specific pathogen, such as Legionella. This was to establish the ability to grow potentially pathogenic species in the subject environment, rather than search for specific pathogens. Our results were that after 2 to 3 heating seasons a number of the tested systems exhibited bacterial counts of 10,000 to 100,000 CFU/cm^2 (colony forming units per square centimeter of growth media). At the 100,000 CFU/cm^2 level issues with pathogens found capable of affecting immune system compromised individuals, such as those on chemotherapy, arise.

Interestingly, there was also other overt evidence of biological growth in the PEX piped heating systems. The systems contained brass flow-check valves. Attachment 2 shows a picture of what was observed on some check valves; there were pin-hole penetrations through the valve bodies. Metallurgical analysis demonstrated that the brass was subject to microbiologically influenced corrosion (MIC). That is the development of bio-slimes in the piping had allowed growth of biota that promote corrosion of metal components. I recently published a peer reviewed article on this finding.[1]

The research literature suggests that there should be concern with application of certain types of plastic piping in domestic water systems. The Ministry of Public Housing, Urban Planning and Environment (The Netherlands) commissioned a study directed specifically at the issue of biological film formation and pathogenic bacteria viability as a function of pipe materials[2]. This study, conducted by Kiwa N.V., a water research consultancy, provides some thought-provoking results. Eight materials in the domestic water piping market were tested, including variants of crosslinked polyethylene (PEXa, PEXc), polybutylene (PB), polypropylene (PP), chlorinated polyvinyl chloride (CPVC), polyethylene/aluminum composite, copper (Cu) and stainless steel (SS). The study showed that under static conditions polyethylene derived pipes (PEXa and PEXc) provided the highest biofilm formation potential of any of the eight materials tested. Even though their analysis showed that the copper piping tested likely had residual oils (which would promote biofilm formation) the PEXa (crosslinking by the peroxide method) tubing still exhibited several times the biofilm formation potential of the copper. Further, this research established that colony counts of inoculated bacteria generally correlated with the propensity for biofilm formation. The paper also showed that certain biota were particularly sensitive to the presence of copper, e.g. no Pseudomonas bacteria

[1] R.A. Clark and D.R. Clark, Microbiologically Influenced Corrosion in Hydronic Heating Systems, Journal of Failure Analysis and Prevention, V. 4 No. 4, Aug. 2004, pp. 38-42

[2] H.R. Veenendaal and D. vander Kooij, Biofilm Formation Potential of Pipe Materials in Plumbing Systems – Measurement Results and Evaluation, Kiwa, June 1999

survived in the copper systems. In their summary of results, the authors' state: "The PE-based materials displayed the strongest biofilm formation and the strongest promotion of the growth of Legionella bacteria."[3]

This study concludes with a recommendation that the static test results become the basis for comparative assessment of piping materials. The reasoning presented is: "The microbiological quality of the water in drinking water installations is (virtually) not inspected and the protection of the microbiological quality therefore rests entirely on prevention."[4]

Other research supports similar conclusions. A well referenced review paper by Momba et al[5] summarizes the many aspects which can affect water quality. This paper notes, "The most alarming results are the presence and multiplication of pathogenic and opportunistic pathogens such as..... occurring within the biofilms." The paper goes on to identify the "factors contributing to biofilm formation" one of which was "the kind of piping material used in the system". It was noted that "Biofilm formation is usually encouraged on the surface of a plumbing material if that material is able to supply the required nutrients for bacterial growth. In countries such as the United Kingdom, the influence of piping material is examined....before their use is permitted." In a later discussion on plastic piping "Despite their many advantages, they also contribute to biofilm formation in drinking water." Addressing control strategies for inhibiting bacteriological deterioration of drinking water the authors emphasize the need to prevent biofilm formation including "Efforts should be made to utilize materials in the network which will suppress the attachment of bacteria...".

There are numerous references in the literature that link the growth of pathogens with biofilm formation. There are also references that specifically identify benefits to the presence of certain metallic elements in inhibiting or eliminating some pathogens of concern. A recent government funded Italian study[6] points out the benefits of having residual copper levels of >50μg/L on inhibiting Legionella and possibly reducing coliform bacteria. A study commissioned by the International Copper Association (ICA)[7] determined that in most cases bacteria grew more on plastic materials than on copper.

In attachment 3 a sheet from an advertising newsletter published by Noveon Europe, B.V.B.A. is provided. Figure 1 on the subject attachment provides a comparison from a referenced study of the bacterial growth in different piping materials. In this case

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[3] Ibid, p. 24
[4] Ibid, p. 40
[5] MNB Momba et al, An Overview of Biofilm Formation in Distribution Systems and its Impact on the Deterioration of Water Quality, Water SA Vol. 26, No. 1, Jan. 2000
[6] Paola Borella, et al Legionella Infection Risk from Domestic Hot Water, Emerging Infectious Diseases, Vol. 10, No. 3, March 2004
[7] J.T. Walker and C.W. Keevil, The Influence of Plumbing Material, Water Chemistry and Temperature on Biofouling Plumbing Circuits with Particular Reference to the Colonization of Legionella Pneumophila. Part 2 1993 ICA Project 437

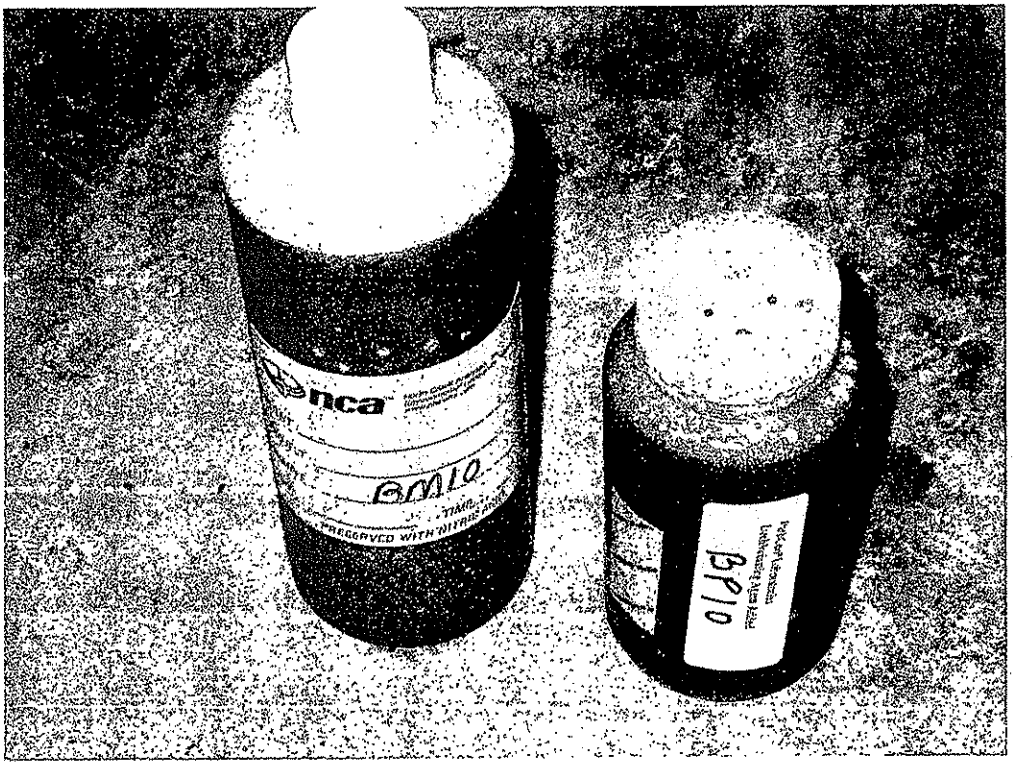
Noveon appears to be extolling the virtues of CPVC (chlorinated polyvinyl chloride). However, note the extremely high bacterial growth values for polyethylene. Noveon previously marketed Flexet™ resin for the manufacture of PEXb (silane crosslinked polyethylene) piping for domestic water applications in North America. Their clients included some of the largest manufacturers of PEX piping including Plasco, Bow, IPEX (Kitec), and Vanguard. Noveon currently markets PEXb resin under the trade name TempRite® to producers such as Bow and IPEX. IPEX is the producer of Kitec® PEX/Aluminum/PEX piping. This composite piping has the same PEX composition in contact with the water as piping without the internal aluminum layer. Therefore its properties with respect to biological growth would be no different than other PEX piping products.

From my personal experience and as evident in the technical literature, there are issues with the promotion of biofilms in cross-linked polyethylene piping. It is established fact that biofilm formation is linked to the growth of bacteria, including known human pathogens. As referenced above there are definite concerns with the qualification and choice of piping materials being expressed in an effort to assure safety in domestic potable water. On the converse side of allowing plastic piping in potable water systems, such a choice also brings about the less obvious, but potentially important, loss of the bactericidal properties that are inherent in using copper piping. A further consideration should be that the commonly used methods of sanitizing systems, exposing them to high heat or high levels of biocide chemicals (e.g. super chlorination) can damage PEX while having virtually no effect on service life of metal piping. I urge the Commission to fully study the ramifications of extending the allowed application of PEX piping. Possible advantages in ease of installation and front-end construction costs may have long term consequences in public safety and durability.

Sincerely,
GT ENGINEERING
(a subsidiary of GlobalTox, Inc.)

Robert A. Clark, Ph.D.
Principal – Materials Scientist

Attachment 1



Water sample acquired from open loop heating system plumbed with PEX tubing. Dark color is from biofilm/slime growth in the PEX tubing. (Blueberry Place 9-28-03 DSCN0843)

NEWSFLOW

January 2002 edition n° 1

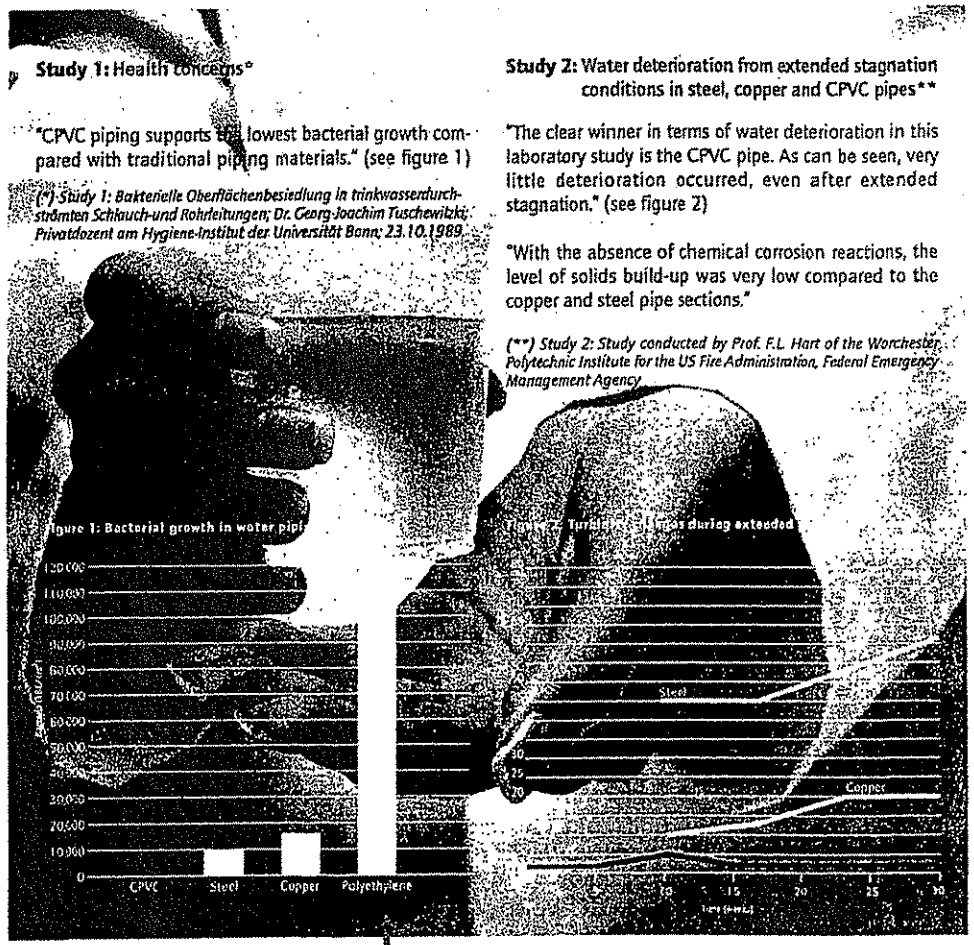
CPVC and bacteria build-up

Recent outbreaks of legionella in Western Europe and other health issues associated with bacteria, have led to heightened awareness of the effect of piping materials on bacterial growth. Studies have shown that bacteria build-up with CPVC is far lower than with alternative piping materials such as copper, steel and other thermoplastics. Below are some results and conclusions of 3 different studies.

Study 1: Health concerns*

"CPVC piping supports the lowest bacterial growth compared with traditional piping materials." (see figure 1)

(*) Study 1: Bakterielle Oberflächenbesiedlung in trinkwasserdurchströmten Schlauch-und Rohrleitungen; Dr. Georg-Joachim Tuschewitzki; Privatdozent am Hygiene-Institut der Universität Bonn; 23.10.1989.



Study 2: Water deterioration from extended stagnation conditions in steel, copper and CPVC pipes**

"The clear winner in terms of water deterioration in this laboratory study is the CPVC pipe. As can be seen, very little deterioration occurred, even after extended stagnation." (see figure 2)

"With the absence of chemical corrosion reactions, the level of solids build-up was very low compared to the copper and steel pipe sections."

(**) Study 2: Study conducted by Prof. F.L. Hart of the Worchester Polytechnic Institute for the US Fire Administration, Federal Emergency Management Agency.

noveon.
The Speciality Chemicals Innovator™

Noveon is a major supplier of PEX resins to the North American market.

THOMAS REID ASSOCIATES
560 WAVERLEY ST., SUITE 201 (BOX 880), PALO ALTO, CA 94301
Tel: 650-327-0429 Fax: 650-327-4024 tra@igc.org

July 23, 2001

Dan Cardozo
Adams, Broadwell, Joseph and Cardozo

Re: Environmental effects of California adoption of PEX for potable water.

Dear Mr. Cardozo:

The state of California is considering adopting a portion of the Uniform Plumbing Code (UPC) which would allow the use of plastic pipe manufactured from cross linked polyethylene (PEX) for potable water use inside dwellings. The installation and use of PEX could result in direct and indirect impacts on the physical environment. If approved, PEX plastic pipe could be installed in thousands of homes in California; because of the potential scope of usage of PEX, these impacts may be cumulatively considerable.

For these reasons, the Department of Housing and Community Development (HCD) needs to comply with the California Environmental Quality Act (CEQA) so that it is adequately informed about the environmental consequences of the proposed approval of PEX. In this letter I outline some of the areas of potential environmental impact. Because PEX is not widely used in the United States, information is not readily available from external sources. Clearly, the present record lacks sufficient information to allow the state to dismiss the potential for environmental impact. Thus HCD should use the CEQA process to gather the necessary information to determine whether or not the impact potential would be realized.

What is PEX?

Cross linked polyethylene is a member of the polyolefin family of polymers – along with normal polyethylene, polypropylene, and polybutylene. Normal polyethylene is unsuitable for use for hot water because it softens at elevated temperatures. Polypropylene and polybutylene have greater temperature resistance because of the higher molecular weight of their monomers and polybutylene can be used in the temperature range of domestic hot water supply.

For polyethylene to serve hot water use, the individual polymer chains must be cross linked together with supplemental chemical bonds. The three commercial methods of cross linking give rise to three classes of PEX:

PEX-A, the so-called Engel method where the polyethylene resin and a chemical additive are heated to produce cross linking;
PEX-B, the silane method which produces silicon-oxygen cross link bonds; and
PEX-C, where cross linking is initiated by gamma or electron beam radiation.

All types of PEX would be permitted under the proposed code as long as they met the requirements of relevant ASTM or NSF testing.
The different manufacturing processes produce slightly different products with different chemical and mechanical characteristics. Historically, the push to allow plastic pipe in California has come from one manufacturer seeking to expand its market. For PEX, the manufacturer pushing for approval represents only one of the three manufacturing methods and has supplied information of limited scope. For HCD to adequately consider the environmental impact of the code adoption, HCD needs to define the "project" under CEQA completely and obtain information about all three commercial forms of PEX.

The cross linking of polyethylene produces the chemical structure necessary to resist softening at elevated temperatures. The cross linking does not change the fundamental chemistry of polyolefin polymers, and hence PEX is susceptible to the same chemical attack from oxidants or ultraviolet light as are other polyolefins. For this reason, PEX resin used to manufacture pipe for plumbing has chemical additives such as antioxidants, ultraviolet blockers, fillers and pigments.

HCD will need to obtain information on all of these additives as well as the underlying manufacturing process and the chemicals that uses. The information is essential for HCD to be able to appraise the potential for chemical leaching and to evaluate factors that may affect mechanical stability and performance of the plumbing system.

Plastic Pipe History

HCD can draw on the past CEQA process for plastic pipe approvals to determine the kind of information which will be necessary to support its considerations of PEX. The CEQA process for plastic pipe considered polybutylene (PB) and chlorinated poly vinyl chloride (CPVC). Although PEX pipe existed in Europe and for certain specialty, non-potable water applications in the United States, PEX was not included in the EIR because of its greater cost relative to the other plastic pipe alternatives and because of the lack of PEX industry participation in the EIR or the chemical leaching tests that were conducted by the state. PEX was not exempted from the past EIR – it was not considered relevant to the California marketplace and hence was not part of the "project".

A proprietary system of PEX tubing and fasteners was proposed for local approval in Los Angeles in 1994, but was not adopted. In the Los Angeles proceeding, requests were made of the manufacturer for disclosure of the cross linking process and the additives in the pipe grade resin. As far as I am able to tell, none of this information was actually provided, and the local approval request was terminated.

During the HCD plastic pipe environmental review process, PB pipe was demonstrated to have significant mechanical stability defects. We developed some of the information

about oxidant degradation of polyolefins that was relevant to the exposure of PB pipe to high levels of residual chlorine and the potable water supply. The prediction of mechanical failure arose from the emphasis that we placed on disclosure of the antioxidant additives that needed to be included in the pipe resin to resist degradation.

Antioxidants function sacrificially. When the pipe resin containing the antioxidant is exposed to an oxidizer (chlorine or oxygen), the antioxidant molecules are preferentially degraded, thereby protecting the polymer molecule itself. Depending on the aggressiveness of oxidizer exposure and environmental conditions, the antioxidant additive in the pipe resin may be consumed rapidly. When the antioxidant is consumed, the polymer itself will be attacked with resulting polymer chain breakage, ensuing loss of strength and brittleness, and ultimately, premature mechanical failure.

This happened to PB pipe. Although touted by the manufacturer as having a lifetime of 50 years or more, some PB installations failed in 5 to 15 years with devastating results for the consumer. Shell Chemical, the major PB manufacture, pulled out of North America with liability exceeding one billion dollars. PEX manufacturers obviously seek to distance themselves from the PB pipe fiasco. HCD should insist, however, that PEX manufacturers provide full information about the antioxidant system used for PEX to show that the failures from PB could not happen with PEX. If the same antioxidant system is being used for PEX as was used for PB, then there needs to be an explanation. The state is being offered the same story with PEX as with PB: "this plastic pipe is used everywhere but California with no problems", but something in the environmental conditions in the arid lands from Southern California and Arizona to Texas caused failures that had not been experienced elsewhere.

Environmental Issues

Several environmental issues are readily identifiable that are relevant to plastic pipe and specifically to PEX. Foremost among these is the concern for public health which includes chemical leaching from the pipe and permeation of the pipe by contaminants in the environment. Based on the PB experience, there is a real concern for consumer protection and reliability of the pipe system. There are also potential issues for fire safety, solid waste management, and air and water quality.

Public Health

Chemical leaching is a complex problem to assess. Obviously, HCD would need to begin with a complete disclosure of the composition of all forms of PEX which may be used in California. This means PEX classes A, B, and C, as described above. HCD would need to identify the potential health risk associated with these chemicals and then assess their potential to be leached into the potable water carried by a PEX pipe. Chemical leaching would also need to take into account breakdown products from

antioxidants and other substances that may be formed in the pipe by reaction with chlorine in the water supply.

PEX plastic pipe manufacturers have not made a disclosure of the necessary information to the state. We can derive a sense of what the leaching problems may be from available sources, but these are not definitive. NSF International, a private code organization, uses ANSI/NSF Standard 61 to certify plumbing materials for health effects in drinking water. NSF certification does not to fulfill HCD's requirements for disclosure under CEQA, as explained later in this letter, but NSF does provide some insight into the chemical leaching potential for PEX.

NSF Table 3.1, Material-specific analyses,, has a "Required Analysis" for "cross linked polyethylene" that includes "GC/MS, VOCs, regulated metals, phenolics (by GC/MS base/acid scan), methanol, and tert-butyl alcohol" NSF 61 (adopted Feb 9, 2001), page 8, with a footnote, "tert-Butyl alcohol analysis is required for PEX materials except those cross-linked via e-beam methodology." (Published text corrected, pers. comm. Jane M. Wilson, M.P.H., Senior Project Manager, Water and Environmental Standards, NSF International, July 20, 2001).

NSF does not normally disclose the results of testing, therefore we have no idea of what compounds have actually been detected by NSF tests for chemical leaching from PEX. The material-specific analyses required give an indication of the kind of information which HCD should seek in order to define the potential public health impact of adopting PEX in California.

Advertising literature from PEX manufacturers also suggests chemical leaching issues. Manufacturers using the PEX-C irradiation process predictably cite the public health benefit of not requiring cross linking chemical additives. The manufacturers of Merflex PEX-C Riser/Supply Tube state, "We have adopted the proven European technology for cross-linking with radiation, avoiding the potential problem of toxicity that is a critical issue in regards to potable water." (http://www.mercuryplastics.com/merf.htm). On the other hand, a manufacturer using the PEX-B silane method claims, "There is available Witco declaration of silane utilised in XLPE [PEX] formulation approved for drinking water pipes unter Eu Directive 90/128/EEC concerning SILQUEST A-171 silane." (http://www.interplast.gr/En/products/como-pex).

Permeation is the phenomenon where relatively low molecular weight substances migrate through a seemingly solid polymer barrier. Permeation is a concern where the ground and groundwater are contaminated with petroleum compounds, with the gasoline additive MTBE, or with pesticides, particularly termiticides. Although most domestic plumbing will be within the structure itself, the approval considered by HCD includes external exposure from the water metered to the structure or under slab for

slab on grade home construction. The latter is a particular concern because of the requirement for treating the sub-slab soil with termiticides in some geographic locations. HCD should request and review laboratory or field test data for PEX permeation. Note that the different types of PEX have different chemical cross-linking characteristics and would be expected to have different permeation behavior.

Consumer Protection and Reliability

Premature mechanical failure of plastic pipe is both a consumer protection and an environmental issue. It is difficult, disruptive, and expensive to replace a plumbing system that has failed. The failed pipe system leaves a homeowner without water, may physically damage the structure and furnishings, and may create conditions in the walls leading to mold which can produce indoor air quality health impacts.

HCD needs to consider the mechanical reliability of the PEX systems that may be used in California. The different crosslinking mechanisms, PEX-A, B, and C, vary in the degree of crosslinking from 40 percent to 90 percent, with corresponding differences in mechanical stability. Although all of the pipe resins may pass ASTM when freshly manufactured, it is possible that different resin systems will react differently to antioxidant depletion and hence behave differently in actual use.

The PB experience is relevant here. Although PEX is not PB, the chemical similarities are enough that HCD should demand more than just marketing literature to assure that mechanical reliability will be adequate. PEX manufacturers apparently claim a 50-year product life, but offer no more than a ten-year warranty on the product.

Fire Safety

The substitution of a plastic product for a metal product poses the obvious concern for fire safety. The plastic pipe carrying water is not likely to be flammable, but exposed to heat in a fire, the plastic pipe will rapidly rupture, draining or de-pressurizing the system and creating openings in wall studs which may encourage fire spread.

The model code attempts to address some of these concerns by requiring fire stopping at pipe penetrations. It would be appropriate for HCD to seek comment by California fire officials on the likely efficacy of these fire prevention mechanisms, particularly in the light of the high seismic activity and associated risk of structure fire in most of the state.

Other Environmental Issues

Several other environmental issues warrant consideration. Solid waste management is important to California. Construction waste and demolition debris are a major portion of the waste stream and much effort has been made in the past 10 years to increase the

amount of construction materials that can be re-cycled and diverted from the landfill. Copper piping is eminently recyclable. There is currently no recycle market for PEX and due to the effect of crosslinking, is unlikely that PEX waste could be used in remanufacturing PEX pipe or any other useful product. Considering the extent of California solid waste legislation and regulation, this subject deserves explicit consideration by HCD.

A complete treatment under CEQA would also consider the air quality effects of manufacturing, installation, and use of plastic pipe and potential water quality effects of chemical leaching as well.

State CEQA Compliance

The state's past involvement in CEQA review of plastic pipe clearly identifies the subject material to be addressed. In addition, specific information about PEX shows that most of these areas of past concern also need present investigation. At a minimum, HCD needs to go through the initial steps of CEQA compliance: defining the project, gathering information and making a preliminary determination through a formal initial study.

Project definition will be difficult for HCD, particularly if there is little cooperation from PEX manufacturers. As noted earlier, it will be necessary for HCD to obtain information on all three primary forms of PEX in the potential California marketplace.

Although manufacturers and NSF International are logical sources of information, it will be necessary for HCD to establish its own capacity for independent review as required by CEQA. The state may be able to find much of the necessary expertise in California EPA; in some cases it may be necessary to obtain expertise outside of state government.

The potential environmental impact from chemical leaching or mechanical failure is obvious. Standards organizations and certification processes can help limit that potential impact, and HCD can make use of those third parties in devising its own requirements for mitigation. The obligation for mitigation, however, remains with HCD. For that reason HCD needs to make sure that it has adequate technical resources available to be able to independently verify that third party standards and certification are adequate.

State Cannot Rely on NSF Alone

NSF International (formerly the National Sanitation Foundation) has emerged as the premier private standards organization dealing with plumbing. NSF operates a voluntary certification program and grants participants the right to use the NSF logo on

their products. The NSF certification involves compliance with mechanical standards and health standards. For this reason, most code organizations require products to have the NSF certification.

The issue of the state of California relying on NSF has arisen in the past in the debate over the use of plastic pipe in California. NSF performs a valuable role, but the state of California cannot delegate to NSF its own obligation for public health and environmental protection. The state of California needs to exercise its independent judgment in the course of CEQA compliance. The state can obtain information from third parties, but the state alone needs to determine the sufficiency and accuracy of that information, and the state needs to make that information available to the public so that the public may be assured that the environmental process has been conducted completely and thoroughly.

The state cannot rely on the NSF certification process to assure the protection of public health because:

1) NSF disclaims responsibility and specifically disallows governmental reliance on its standards.
2) NSF does not release the results of tests on the materials it certifies.
3) NSF's testing protocols may not be adequate to determine the potential for chemical leaching.

NSF 61 contains strong disclaimers of responsibility:

> "Disclaimers
>
> "NSF International (NSF): in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of NSF represent its professional judgment. NSF shall not be responsible to anyone for the use of or reliance upon this standard by anyone. NSF shall not incur any obligations or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.
>
> "Participation in NSF's standards development activities by a representative of a regulatory agency (Federal, state, local) shall not be construed as the agency's endorsement of NSF, its policies, or any of its standards.
>
> "NSF standards provide basic criteria to promote and protect public health. Provisions for safety have not been included in this standard because governmental agencies or other national standards-setting organizations provide safety requirements." (ANSI/NSF 61, page iii)

valid reason to shortchange the CEQA process.

Sincerely,

Thomas S. Reid

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April 3, 2002

Dan Cardozo
Adams, Broadwell, Joseph and Cardozo
651 Gateway Boulevard, Suite 900
South San Francisco, CA 94080

Re: Information on environmental effects of PEX use for potable water.

Dear Mr. Cardozo:

The State of California is considering adopting a portion of the Uniform Plumbing Code (UPC) which would allow the use of plastic pipe manufactured from cross linked polyethylene (PEX) for potable water use inside dwellings. I conveyed a summary analysis of the potential environmental effects of this action in my July 23, 2001 letter.

I concluded that the installation and use of PEX could result in direct and indirect impacts on the physical environment. If approved, PEX plastic pipe could be installed in thousands of homes in California and because of the potential scope of usage of PEX, these impacts may be cumulatively considerable.

For these reasons, the Department of Housing and Community Development (HCD) needs to comply with the California Environmental Quality Act (CEQA) so that it is adequately informed about the environmental consequences of the proposed approval of PEX.

I have reviewed the State's file on this material which includes material submitted after my July 23, 2001 letter. I find nothing of substance in this new material that changes my opinion that the consumer in California would benefit from an objective, public review, as would be afforded by HCD compliance with the CEQA process.

I identified several issues where HCD needs to resolve potential environmental effects of PEX adoption.

PEX Composition.

Different manufacturing processes produce slightly different products with different chemical and mechanical characteristics. The manufacturer pushing for approval represents only one of the three manufacturing methods and has supplied information of limited scope. For HCD to adequately consider the environmental impact of the code adoption, HCD needs to define the "project" under CEQA completely and obtain information about all three commercial forms of PEX.

Oxidant degradation of polyolefins from high levels of residual chlorine in the potable water supply can cause mechanical failure. Depending on the aggressiveness of oxidizer exposure and environmental conditions, the antioxidant additive in the pipe resin may be consumed rapidly leading to rapid resin degradation. This is a major factor in the failure of polybutylene (PB) pipe. Although industry proponents seek to distance themselves from PB, it is valid for the State to ask for disclosure of the antioxidant additives that are included in the PEX pipe resin to resist degradation. Are these the same as were used for PB?

Mechanical Stability

PEX supporters claim a long history of successful PEX use – this is the same story given by Shell Chemical which touted a PB lifetime of 50 years or more. Nonetheless, in expanded use, some PB installations failed in 5 to 15 years with devastating results for the consumer. The PEX proponents have not submitted information to show why this would not happen again.

Merely citing PEX popularity as does John Messick (November 27, 2001) does not provide objective information. Mr. Messick believes that problems with PB should not be applied to PEX, but the oxidation problem for polyolefins is not changed by crosslinking alone. Merely saying that "problems with PB are well known" ignores the fact that past popularity of PB Shell Chemical to a nearly $1 billion product liability settlement.

Robert Friedlander, PPFA (November 29, 2001) and Rich Houle, Wirsbro (November 28, 2001) cite the new ASTM Test Method F2023-00 "Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water". This method helps address the potential problem, but it is important for HCD to be able to independently review the results of the testing and understand why the test method applied to PEX differentiates from the similar methods applied to PB. Relevant standards are good; their existence is not a substitute for the judgement of the state.

Public Health

Industry has not yet dealt directly with the issue of public health. We raised the issues of chemical leaching and permeation from environmental contaminants. These are complex problems to assess and must begin with a complete disclosure of the composition of all forms of PEX which may be used in California. Chemical leaching would also need to take into account breakdown products from antioxidants and other substances that may be formed in the pipe by reaction with chlorine in the water supply.

Waste and Energy

Solid waste management is important to California. Construction waste and demolition debris are a major portion of the waste stream and much effort has been made to increase the proportion of construction materials that can be re-cycled and diverted from the landfill.

Copper piping is eminently recyclable. There is no recycle market for PEX due to the effect of crosslinking. PPFA claims that PEX waste can be burned for fuel, but that is not acceptable as recycling in California. Mr. Messick cites potential energy savings, without citation. The energy cost of copper produced through recycling is favorable and copper is routinely recycled. The incremental benefit from lower heat conductivity for PEX compared with copper should be minimal if hot water pipes are insulated in accordance with current codes. Considering the concern for energy supply and the extent of California solid waste legislation and regulation, this subject deserves explicit consideration by HCD.

Conclusion

The recent additions to the file do not actually supply new information. The manufacturers and NSF could have done so, but they did not. Clearly, the present record lacks sufficient information to allow the state to dismiss the potential for environmental impact. HCD should gather the necessary information in accordance with CEQA to determine whether or not the impact potential would be realized. Ironically, if industry had cooperated and supplied relevant manufacturing data and third party test results, the process could have been completed by now.

Sincerely,

Thomas S. Reid

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January 13, 2003

California Building Standards Commission
915 Capitol Mall, Suite 200
Sacramento, CA 95814

Re: Additional information substantiating the potentially significant public health, consumer protection, and environmental effects of adopting PEX pipe for potable water use.

Chair and Members of the Commission:

This letter submitted on behalf of the California Pipe Trades Council provides additional information for the Building Standards Commission to consider in approving the use of PEX pipe for potable water in California. I wrote two earlier letters on this subject, dated July 23, 2001 and April 3, 2002, which were submitted to the Commission. Those letters described several reasons why the Commission would need to consider the potentially significant public health, consumer protection, and environmental effects of adopting PEX pipe for potable water use. I concluded that the Commission would need to obtain information and subject it to an independent analysis.

1. Wirsbo Disclosure in Defren v. Trimark Homes.

The PEX pipe industry has not cooperated with the Commission and has not provided key information about the material. Nonetheless, some new information has come from a series of documents in a lawsuit filed in Arizona. One document was submitted by Uponor Wirsbo, a major PEX manufacturer, as third-party defendant in Defren v. Trimark Homes (Arizona). The material in the disclosure is referenced by the Bates number, e.g. WIRS0265.

This manufacturer disclosure substantiates the chemical leaching and chemical permeation issues raised in my earlier letters. The disclosure also indirectly confirms the polymer oxidation and product reliability issue.

Wirsbo is the manufacturer of AQUAPEX and is one of the largest North American PEX distributors. AQUAPEX is made from PEX-A, cross linked polyethylene manufactured through the Engle method. The Engle method involves extruding the pipe resin with a peroxide catalyst and other additives.

According to her complaint, plaintiff Joyce Defren purchased a house from Trimark Homes in Scottsdale, Arizona. The house was plumbed with AQUAPEX. Ms. Defren found the water to have a bad taste and she was concerned about the health effects of chemicals in the water. When the water was tested by a lab it was found to have several organic chemicals present: Methyl-tert-Butyl ether (MTBE), tert-Butyl alcohol (TBA), and various benzene-type aromatic hydrocarbons.

Wirsbo claims that the MTBE and TBA are "by-products of the manufacturing process" (Uponor Wirsbo initial rule 26.1 disclosure statement, p. 3).

Wirsbo claims that the benzene chemicals were the result of a termiticide formulation permeating the pipe and that the company is not at fault because it warns against exposing pipe to potentially permeating compounds: "The permeable characteristics of cross-linked polyethylene tubing prohibit installation in soil or ground water contaminated with solvents, fuels, organic compounds or other detrimental materials". (Wirsbo disclosure statement, page 2.)

2. PEX permeation is a significant problem.

I have raised permeation as a potentially significant environmental and health and safety effect. Information from the Arizona lawsuit, the, Plastic Pipe and Fittings Association and the Plastic Pipe Institute bears out my concerns. In my July 23, 2001 letter, I said,

> "Permeation is the phenomenon where relatively low molecular weight substances migrate through a seemingly solid polymer barrier. Permeation is a concern where the ground and groundwater are contaminated with petroleum compounds, with the gasoline additive MTBE, or with pesticides, particularly termiticides. Although most domestic plumbing will be within the structure itself, the approval considered by HCD includes external exposure from the water metered to the structure or under slab for slab on grade home construction. The latter is a particular concern because of the requirement for treating the sub-slab soil with termiticides in some geographic locations. HCD should request and review laboratory or field test data for PEX permeation. Note that the different types of PEX have different chemical cross-linking characteristics and would be expected to have different permeation behavior."

In Thermoplastic Piping For The Transport Of Chemicals, January 2000, The Plastics Pipe Institute (http://www.plasticpipe.org), states, "In general, chemicals that affect plastics do so in one of two ways. One effect is chemical solubility or permeation. The other is direct chemical attack. In the case of solubility or permeation, physical properties may be affected, but the polymer molecule

structure itself is not chemically changed, degraded or destroyed. In solubility or permeation, gas, vapor, or liquid molecules pass through the polymer, typically without damaging the plastic material itself. ... Permeation may do little if any harm to the material, but it may have application-related effects. The permeating chemical may transfer into a fluid on the other side of the pipe. In general, thermoplastic pipes should not be used where a permeating chemical could compromise the purity of a fluid such as potable water inside the pipe ..."

The PEX Industry acknowledges the limitation and warns "Do not allow tubing to come in extended contact with any of at least the commonly encountered construction materials listed below: (This list is not all-inclusive.) Pipe thread sealing compounds; Fire wall penetration sealing compounds. Exception: water soluble, gypsum-based caulking; Petroleum-based materials such as: Kerosene Benzene Gasoline, Solvents, Fuel Oils, Cutting Oils, Asphaltic Paint, and Asphaltic Road Materials." and "Do not place any PEX tubing in heavily contaminated soils or other heavily contaminated environments." (The Plastic Pipe and Fittings Association, 2002 Installation Handbook: Cross-linked Polyethylene (PEX) Hot and Cold Water- Distribution Systems, page 4.)

The Engle method PEX-A is usually more highly cross-linked than the other types, PEX-B, the silane method which produces silicon-oxygen cross link bonds, and PEX-C, where cross linking is initiated by gamma or electron beam radiation. Thus the permeation liability for AQUAPEX will be shared by all PEX pipe.

3. There is a high risk of PEX permeation in California from MTBE and other fuel contamination.

Soil and ground water contamination from petroleum fuels is widespread in California. Most of the toxic contaminated sites in the state are leaking underground storage tanks. Despite a major effort at replacing tanks and remediating soils, large areas are still contaminated with gasoline and other fuels.

This problem was greatly exacerbated by the adoption of MTBE as a motor vehicle fuel additive when it was found that MTBE is far more mobile in ground water and that even low levels of water contamination is noticeable. "It is possible your water would taste and/or smell like turpentine if MTBE is present at levels around or above 20-40 ppb (some people may detect it at even lower levels)." (US EPA at http://www.epa.gov/mtbe/water.htm) Ppb stands for parts per billion, also expressed as micrograms per liter ug/L.

Possible contamination is widespread. "Contamination of drinking water sources can occur from leaking underground and above ground fuel storage tanks, pipelines, refueling spills, automobile accidents damaging the fuel tank, consumer disposal of "old" gasoline", emissions from older marine engines, and

So far the concern is for contamination of wells and public water supplies. The assumption is that the public will be safe if the water supply is safe. That situation would change drastically if thousands of new homes are built with under slab PEX piping subject to permeation.

The evidence that MTBE may permeate PEX is significant. The PPFA Installation Handbook states that materials such as Gasoline, Kerosene and Fuel oils should not be allowed contact with PEX, and that PEX should not be placed in any heavily contaminated soils. MTBE has been a component of gasoline, which can contaminate soil. The Arizona lawsuit demonstrates that MTBE was found in water inside PEX piping. The manufacturer of that piping claims that the MTBE is a byproduct of production, which would be a threat to public health and safety. Alternatively, the MTBE could have come from contaminated soil, which would also be a threat to public health and safety. These are significant risks for California.

4. There is a high risk of PEX permeation by Termiticides in California.

The heart of Defren v. Trimark is the substantial permeation of the PEX potable water pipes by termiticide formulation in the soil. Although the affected home is in Arizona, the same under-slab soil treatment is widely practiced in California.

Termiticides are both applied prior to new construction and frequently after construction. As more toxic compounds have been excluded from use, the need for more frequent application has increased. Note that it is not simply the active ingredient that is of concern, but the petroleum based solvents needed for these inherently insoluble compounds. It is likely that it was the "inert" petroleum carrier for the active pesticide ingredient that contributed the high levels of substituted benzenes to the water in Ms. Defren's house (see below).
Nearly every home in California is potentially affected. The volume of termiticide applied is staggering. Lewis (UC Berkeley) summarizes,

"In the United States control and damage repair costs due to subterranean termites exceed $5 billion per year (Su Scheffrahn 1990). In California, these costs exceeded $300 million per year a decade ago (Brier, Dost, & Wilcox 1988). Chemical barriers have been the dominant means of protecting the multi-billion dollar national investment in wood-in-service for more than 50 years. Since the early 1940's when chlorinated hydrocarbons were shown to have biological activity against insects, chemical barriers have been the mainstay of the pest control industry in combating subterranean termite infestations. In California, the risk homeowners face in having a termite infestation is substantial; 30% of all structural pest inspection reports (over 1.5 million conducted per year) reveal signs of active subterranean termites (Brier, Dost, & Wilcox 1988).

"In California, over 7.6 million liters (more than 76,000 kg of active ingredient) of termiticides were applied for termite control in the 6 San Francisco Bay Area

counties from 1986 - 1990 (D. Carver, unpublished data). Literally all of these termiticides are placed under or adjacent to structures occupied by people at a time when public concern over toxic chemical usage is increasing." Field Comparison of Sand or Insecticide Barriers for Control of Reticulitermes spp. (Isoptera: Rhinotermitidae) Infestations in Homes in Northern California, Vernard R. Lewis, Michael I. Haverty, Douglas S. Carver, and Calvin Fouche. Emphasis added.

The biggest problem with termite control under slab is pipe penetrations which must be left loose to avoid damage to the pipes. Pest control operators inject termiticide directly around the pipes. There is no way that this post construction exposure can be avoided.

If termiticides permeate PEX, as alleged in the Arizona lawsuit, then use of PEX would be a significant health and safety and environmental problem in California.

5. The BSC should evaluate the potential magnitude of the permeation problem before adopting PEX as a plumbing material.

Wirsbo's defense in Defren v. Trimark Homes was "Where such [contaminated] conditions are suspected, chemical analysis of the soil or ground water should be performed before installation". This is not a realistic requirement. The State of California might be able to impose a requirement for soil testing as mitigation for potential permeation impacts on PEX installations. But this would not address the problem of contamination that happens after the pipe is installed. A homeowner with PEX under slab cannot be barred from remedial termite work.

The BSC is the only body that can consider the full scope of the permeation problem in California and decide what limitations are needed. The manufacturer's approach is to disclaim any liability – that does not protect the consumer.

6. Chemical leaching from PEX has not been disclosed.

Chemical leaching is when substances in the pipe leach into the drinking water. There has been no disclosure to the state of any leaching potential from PEX. Clearly industry knows of the leaching potential, has advised NSF International of certain known chemicals, and has reviewed its own tests.
Disclosure is critical to the state's ability for independent review. The state cannot rely on NSF certification alone. As stated in my July 23, 2001 letter,

"NSF performs a valuable role, but the state of California cannot delegate to NSF its own obligation for public health and environmental protection. The state of California needs to exercise its independent judgment in the course of CEQA compliance. The state can obtain information from third parties, but the state alone needs to determine the sufficiency and accuracy of that information, and

the state needs to make that information available to the public so that the public may be assured that the environmental process has been conducted completely and thoroughly.

"The state cannot rely on the NSF certification process to assure the protection of public health because:

1) NSF disclaims responsibility and specifically disallows governmental reliance on its standards.
2) NSF does not release the results of tests on the materials it certifies.
3) NSF's testing protocols may not be adequate to determine the potential for chemical leaching."

When forced by litigation in Defren v. Trimark Homes, Uponor Wirsbo did provide some chemical leaching test results. In its own tests of Ms. Defren's home, Wirsbo found a range of chemical leachate (by Spectrum Labs, St. Paul MN, WIRS 0001 to WIRS 0011 and by Orange Coast Analytical, Phoenix, AZ, WIRS 0044 to WIRS 0078.) Concentrations are reported, but the conditions under which the samples were taken are not known.

Aromatic Compounds
- n-Butyl Benzene
- 1,2,4-Trimethylbenzene
- numerous other alkyl substituted benzenes

Halogenated Compounds
- Bromodichloromethane
- Bromoform
- Chloroethane
- Chloroform
- Dibromochloromethane

Alkyl Compounds
- None reported,
- tert-Butyl Alcohol not specifically tested by Spectrum,
  - tested with a 10 ppb detection level by Orange Coast.

The benzene family concentrations were very high, with total concentrations of Tentatively Identified Compounds (TIC) in the range of 69.89 ppb ("Kitchen", WIRS0011) to 224.38 ppb ("Rear Hose", WIRS005). NSF finds Toluene, Methyl hexanone and isomers 54 ppb, DTBP and other unidentified organics, but not nearly at the concentrations of the substitute benzene TIC's. It is reasonable to conclude that these substances were introduced into the pipe by permeation.

The Halogenated Compounds are not expected normally in a polyolefin pipe product. They may have been present in the municipal water supply, but no blank sample was tested. When using purified water, NSF did find 2,2

Dichloropropane (1.7 ppb) and Chloroform (6.2 ppb, WIRS0115, 2.6, WIRS0124).

MTBE was not reported in Wirsbo's own tests, although acknowledged in the Initial Disclosure statement. NSF finds MTBE with normalized concentrations of 15, 17, 22 ppb. The EPA action level is 20 ppb. MTBE may be associated with the DTBP crosslinking agent added to pipe resin. Consistent with this, a Norwegian study, "VOCs leaching from PEX pipes gave an intense odour of test water. Several of the migrated VOCs were not identified. Oxygenates predominated within the identified VOC with methyl tert-butyl ether (MTBE) as a major component." Potential water quality deterioration of drinking water caused by leakage of organic compounds from materials in contact with the water. Lars J. Hem. Proceedings, 20 th NoDig conference, Copenhagen May 28-31 2002.

NSF requires specific testing of non-radiation cross-linked PEX for 2-Methyl-2-propanol, also known as tert-Butyl Alcohol (TBA). NSF 61 (adopted Feb 9, 2001), Table 3.1, Material-specific analyses. The reason is probably that TBA is the main product produced when the Engle method cross-linking agent Di tert-Butyl Peroxide reacts with the polyethylene in the raw resin.

TBA was not really part of the field testing. In the submitted material, NSF finds substantial amounts of TBA in leachate from Wirsbo PEX. The normalized concentrations are very large, ranging from 2300 to 5300 ppm.

TBA is generally not considered to be a highly hazardous compound, although National Institute of Health studies found some evidence of carcinogenicity in test animals, Toxicology and Carcinogenesis Studies of t -Butyl Alcohol (CAS No. 75-65-0) in F344/N Rats and B6C3F1 Mice (Drinking Water Studies), May 1995. (http://ntp-server.niehs.nih.gov/htdocs/LT-Studies/TR436.html).

We note, however, that the NSF results for TBA are very high. The State should make its own evaluation of how NSF sets the Single Product Allowable Concentration (SPAC) for this unregulated contaminant (Annex D of NSF 61), how the test results are scaled by assumptions of dilution in actual use, and how PEX products exceeding the SPAC can still be certified.

The halogenated compounds are largely known carcinogens. Are they in the pipe? Are the formed by residual chlorine reaction with pipe components? The BSC has a right to find the answers before approving PEX.

These tests raise significant questions about the safety and environmental impact of PEX. The Commission should obtain the answers to these questions prior to considering whether to approve PEX.

7. PEX oxidation and failure has not been addressed.

The organic molecules making up PEX pipe are subject to chemical degradation. The need to stabilize pipe resin during manufacture and in use is a driving chemical engineering problem for all plastic pipe manufacturers:

"Oxidation can weaken plastics, degrade oils, and destroy the integrity of coatings. These chemical changes can eventually result in performance and appearance changes in the material. Antioxidants are particularly important in plastics, since most plastics undergo one or more high-temperature processing steps, usually at the beginning of their life cycles. The Segment Plastic Additives of Ciba Specialty Chemicals has developed two basic types of antioxidants. One type -- processing stabilizers -- is designed to help the plastic survive the initial high-temperature processing step, whilst the other -- antioxidants listed below-works to prevent oxidation over the service life of the plastic article." (http://www.specialchem.com/storefronts/ciba/products/antioxydants.asp, emphasis added.)

The phrase service life of the plastic is key. The antioxidants have a finite life, determined by the magnitude of product exposure to oxidizers, heat, and sunlight. As stated in my July 23, 2001 letter:

> "Antioxidants function sacrificially. When the pipe resin containing the antioxidant is exposed to an oxidizer (chlorine or oxygen), the antioxidant molecules are preferentially degraded, thereby protecting the polymer molecule itself. Depending on the aggressiveness of oxidizer exposure and environmental conditions, the antioxidant additive in the pipe resin may be consumed rapidly. When the antioxidant is consumed, the polymer itself will be attacked with resulting polymer chain breakage, ensuing loss of strength and brittleness, and ultimately, premature mechanical failure."

The manufacturers clearly recognize this:

The Plastic Pipe and Fittings Association, 2002 Installation Handbook: Cross-linked Polyethylene (PEX) Hot and Cold Water- Distribution Systems, has two warnings about exposure to chlorine: "Do not use in swimming pool piping systems." and for chlorine disinfection, "Thoroughly flush all lines of the system at the end of the disinfection period. Failure to do so may damage the plumbing system."

Literature from the PEX manufacturers recognize that PEX cannot be left out in sunlight for long, as discussed below. This is because sunlight can oxidize the piping materials, which can lead to failure of the pipe. The PPFA Handbook (p. 6) warns, "avoid exposure to sunlight ", Wirsbo itself says less than 30-days (AQUAPEX Handbook, p. 25). The problem here is that sun (UV light) initiates

free radicals which threaten the integrity of the plastic and use up the antioxidant reserve capacity.

PEX manufacturers probably use different additives. Wirsbo uses Irganox 1076 (Ciba AO-76 , Chemical Name:Octadecyl-3,5-di-tert-butyl-4-hydroxyhydrocinnamate, CAS No.:2082-79-3) at roughly 0.5% by weight and some other compound not identified in the record. Some of the degradation products of Irganox 1076 may be detected at low levels in the water samples as the TIC's. The role of the related antioxidant, Irganox 1010, used in PB, was studied earlier by the state in the EIR on plastic pipe. Degradation products were observed which demonstrated the progressive loss of antioxidant capacity as the pipe ages. Lars J. Hem, op. cit., also observed "Degradation products from phenol-based antioxidants were major migrants from HDPE pipes." HDPE and PEX use similar antioxidants.

The BSC can bear in mind the tremendous financial loss and inconvenience to consumers from the failure of Polybutylene (PB), another polyolefin pipe material. The PEX industry is profiting from the demise of PB, but does not seem willing to openly discuss the known limitations of it product.

* * *

The accumulating evidence supports a decision by the Building Standards Commission to subject PEX to an independent and public review. Only then will the health and environmental interests of the public be served.

Sincerely,

Thomas S. Reid

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September 9, 2003

Dan Cardozo
Adams, Broadwell, Joseph and Cardozo
651 Gateway Boulevard, Suite 900
South San Francisco, CA 94080

Re: Environmental effects of California adoption of PEX-AL-PEX for carrying potable water.

Dear Mr. Cardozo:

I have reviewed and studied the available data pertaining to the use of plastic pipe manufactured from cross-linked polyethylene (PEX) for potable water use inside dwellings. Based on this review I prepared several technical comment letters addressing the potential for adverse environmental and health and safety impacts arising from the use of PEX to carry potable water. These technical reviews were submitted as comments during the 2001 California Plumbing Code approval process and formed, in part, the evidentiary basis for barring, pending further review, the unregulated use of PEX to carry potable water.

The 2003 Uniform Plumbing Code ("UPC") has added a new version of PEX piping not included in the previous UPC: PEX-AL-PEX. PEX-AL-PEX is a PEX composite consisting of a thin layer of PEX in an aluminum tube and then coated on the outside with PEX. This layer of aluminum may or may not mitigate some of the serious problems PEX has with the permeation of pesticides, gasoline and other contaminants from the outside environment through the PEX piping and into the drinking water carried within. However, the potentially serious problem of the leaching of harmful chemical compounds from the PEX piping itself into the drinking water most likely *remains unmitigated* since the potable water will still be directly in contact with PEX.

Since the adoption of the 2001 California Plumbing Code, Wirsbo, a major PEX manufacturer has disclosed that PEX does have chemical leaching problems including problems with the leaching of MTBE (methyl tertiary butyl ether) and TBA (tertiary butyl alcohol) which are by-products of the

manufacturing process. Furthermore, testing by NSF International, a private model code organization, has found MTBE in potable water flushed through PEX piping in concentrations of 15, 17 and 22 parts per billion. The taste and odor threshold for MTBE is 5 parts per billion and the EPA action level is 20 parts per billion, showing that the leaching of MTBE, a known human carcinogen, is indeed a serious concern.

The chemical leaching problem observed in PEX is likely not mitigated in the new PEX product, PEX-AL-PEX, since the PEX interior is the same and thus should logically have the identical leaching problems. In my opinion, the potential chemical leaching problem of PEX-AL-PEX, as with PEX, requires further study and full disclosure by the manufacturers in order to ensure that this product is safe for carrying potable water.

Sincerely,

Thomas S. Reid