GT ENGINEERING

June 17, 2008
08-032

Ms. Valerie Namba, Senior Environmental Planner
California Department of General Services, Real Estate Services Division
Professional Services Branch, Environmental Services Section
707 Third Street, Third Floor, MS 509
West Sacramento, CA 95605-9052

RE: Draft Environmental Impact Report – Adoption of Statewide Regulations Allowing the Use of PEX Tubing

Dear Ms. Namba:

On behalf of the California Pipe Trades Council, I have been requested to respond to your PEX Draft Environmental Impact Report (DEIR). I have previously provided comments in my June 28 and June 29, 2005 letters to the California Building Standards Commission, copies of which are attached. GT Engineering specializes in forensic investigations for the insurance industry, legal offices, governmental agencies, and manufacturers. As a principal materials scientist I have had extensive involvement with investigation of numerous failures in plastic plumbing components, and in particular with cross-linked polyethylene (PEX). The following paragraphs express concerns I have with statements and assumptions in the DEIR.

Alleged Isolated Failure of UltraPEX

In my June 28, 2005 letter there was discussion of pervasive failures of UltraPEX piping manufactured by Plasco. In your DEIR you refer to the failures of UltraPEX Lot 7 as "attributed to a specific defective lot" and "not representative".[1] This is an erroneous statement. In my investigation of the production of UltraPEX, the quality control (QC) test records maintained by Plasco, and our own laboratory analyses, I did not reach a conclusion that the product wasn't correctly fabricated. All tested UltraPEX tubing material, including material subject to early failure, was adequately cross-linked, indicative that the approximately correct levels of ingredients were employed. Plasco UltraPEX Lot 7 material met ASTM and NSF standards in effect at the time of manufacture. I was also presented during deposition by Noveon (Lubrizol) with Jana Laboratories studies that indicated the material met the then new NSF standard for chlorine resistance.[2] Silane-type PEX is manufactured by co-extrusion of the polyethylene resin and a masterbatch resin that contains antioxidative stabilizers as well

[1] Study PEX DEIR at p.4.2-10
[2] Deposition of Robert A. Clark, Ph.D., May 26, 2005, In the Court of Common Pleas, Cuyahoga County, OH. Case No. CV 04 546025.

18372 Redmond-Fall City Road • Redmond, WA 98052 • Tel 425-556-5555 • Fax 425-556-5556 • www.gt-engineering.com

as the catalyst necessary for cross-linking the product. The correct amount of masterbatch containing the cross-linking catalyst must be incorporated into the extruded product to achieve full cross-linking. The inferiority of this product does not stem from Plasco's manufacturing activity but rather of the capabilities of the resin formulation from which it was fabricated. Also, I would like to make sure it is clear that "Lot 7" is not construed as some minor subset of Plasco production; Lot 7 is the designation for all Plasco production, estimated at hundreds of miles, of piping made from Flexet resin. Another issue possibly involving quality control concerns exposure to ultraviolet light (UV). Defendants in the class action against Plasco would have it that the problems with UltraPEX stem from faulty packaging, storage and handling leading to excessive UV exposure. I have personally conducted studies that differentiate between losses of antioxidant stabilizers due to UV exposure and those due to leaching and thermal degradation and found that UV exposure is not the dominant factor in the failure of the UltraPEX tubing/pipe. That said, the material is quite sensitive to loss of properties upon short-term (~2 week) exposures to UV.

As a further comment on the Plasco UltraPEX product as being 'not representative', counsel for Noveon (Lubrizol, successor to AT Plastics) has represented that all manufacturers of PEXb (silane type) used the same resin formulation in the mid to late 1990s,[3] that is they all purchased AT Plastic's Flexet™5100 resin/Flexet™725 catalyst for use in PEX tubing. According to plaintiff counsel in the class action against Plasco (since acquired by the Wirsbo), it is not true that some of these other manufacturers are not suffering early failures. The rate of failures noted may be a matter of circumstance, for example the quantities of tubing employed for radiant heating versus potable water plumbing. As stated in my June 28, 2005 letter, the early UltraPEX failures were largely attributable to use of an incompatible intumescent firestop material at a series of condominium complexes. However, our subsequent investigation revealed the excessive loss of antioxidative stabilizer throughout the PEX piping. After scientific study of numerous cases, including residences in an area where the water was not chlorinated, it is my conclusion that this material, in typical use for hydronic heating, will not survive for near the 25 year warranted period. I will address extrapolated lifetimes later in this letter however, in my opinion it would be premature and improper to consider the performance of UltraPEX as an isolated instance of poor product, especially one blamed on the manufacturer. It is, and has been my opinion expressed in deposition, that as PEXb produced in the mid to late 1990's to the same formula as UltraPEX reaches on the order of 15 years age in hydronic heating or recirculating hot water applications, that the weakness of the formulation will result in widespread failures. The rather recent rash of Kitec PEX-Al-PEX tubing failures appears to sustain my position. Kitec tubing used the Flexet resin system during the period Plasco produced lot 7. Originally it was considered that the aluminum barrier would prevent through-wall failures. What has been recently found is that the thin layer aluminum rapidly corrodes through.

---

[3] Ibid, p. 92/96.

This leads into my next concern with respect to application of PEX, it has been my experience that in the plastics industry there exist opportunistic manufacturers who have insufficient knowledge about their product and its applications. In the matter of Plasco, if one were to carefully read the UltraPEX application instructions and warrantee, one might easily reach the conclusion that it is a copy of the Wirsbo AquaPEX literature. Yet the Plasco product is considerably different from the Wirsbo product. Plasco relied completely on their resin supplier for any representations as to product longevity, information the resin supplier would not produce during litigation. In fact, after Plasco had introduced their UltraPEX product, Flexet™ resin supplier, AT Plastics, sent a letter (see attachment 1) that limits application of the product to conditions significantly below those advertised in the Plasco product literature. Perhaps one of the banes of the plastics industry is that with limited capital expenditure and very little knowledge of the material, one can be sending product out into the marketplace.

Installation and Use in Accordance with Product Instructions

The DEIR finding appears to rely heavily on the sufficiency of PEX when installed and used per the manufacturer's instructions. Examples are cited of the need to assure that allowed firestop materials are employed, that the material is not excessively exposed to ultraviolet (UV) radiation, and that PEX would not be appropriate in certain contaminated soils. The DEIR ultimately relies on "manufacturer's instructions"[4] to justify use of a system that is not inherently unsafe. I disagree with this logic. The preponderance of systems as-installed and used in the real world needs to be inherently safe. Based on my own experience, having dealt extensively with construction related lapses leading to litigation, it is not reasonable to assume that manufacturer's instructions are applied, or even known, or that a competent professional (much less a higher priced professional) would be used. Furthermore, I don't see how it is appropriate to rely on manufacturer's instructions as a basis for approval of a material when there is no requirement as to the content of said instructions, the level of knowledge of the manufacturer, and really no assurance that instructions reach the end user, the installer in the field.

Let me provide some specific examples and compare them, as appropriate, to copper piping/tubing. In regards to firestop material, it is my experience that where intumescent (heat expanding) firestop material is specified, the PEX piping manufacturers often only allow their own label product. I have been at numerous field installations where there is more than one PEX product. It does not appear to be uncommon that the plumbing subcontractor may mix equivalent sized piping product from different manufacturers. It is likely that each of these manufacturers may require a different firestop and not, in my opinion, likely that the installing plumber will be aware of the difference. I have also experienced recognized name brand firestop materials which are labeled for application to PEX piping, yet have led to failure of some PEX pipe brands. The "Triple S Intumescent Sealant" specifically referred to in the DEIR as "designed to be compatible

[4] DIIR at p.4.2-10

with PEX"[5] was found to be incompatible with the UltraPEX piping and, therefore, would be incompatible with other products produced from the same resin.

With the recognized weakness of PEX to UV exposure has come better packaging over the years. Product was once delivered in large rolls covered with clear plastic; now packaging is generally opaque plastic or in cardboard boxes. To my knowledge, such packaging is not a requirement of any code, rather a response of knowledgeable manufacturers to a known material short-coming. What mechanism exists to prevent a low-cost off shore supplier from shipping inadequately protected material? What controls will be in place at the work-site where any inconvenience in packaging is dealt with by removing the product? What guarantees that once the PEX piping is installed into a structure that the piping is protected from exposure by timely enclosing of the walls?

The DEIR also fails to address the issue of post-installation vulnerability. As an example, the DEIR doesn't address the consequences to an application where PEX is installed and there is subsequent lying of asphalt, as for driveways and walkways, with accompanying oils. Also, many household products are petroleum and/or solvent based, including paints, and insecticide sprays; there is a lack of data cited in the DEIR on how PEX may respond to these products.

The use of PEX piping obviously should be compared to existing permissible materials, primarily copper tubing, for potable water applications. On the job site there is little that one can do to copper to impugn its future functionality; if copper is damaged it is generally physically visible. There is no uncertainty associated with if and how long the material has been exposed to sunlight (UV). Soil conditions won't affect water quality or, in general, pipe integrity. There is no issue of chemical migration through copper. Plumbers are familiar with copper piping and there are a limited number of long-term accepted methods of installation. Also, if there is faulty installation, one is generally presented with a leak at the time of pressure testing. Copper piping conforming to ASTM specifications has little compositional variability; it will behave in a known and predictable manner regardless of the source. PEX pipe is not one material, it is a class of materials potentially requiring different handling methods depending on the manufacturer. Different manufacturers require their own fastening systems, their own limitations on firestopping, and have different criteria on repairs. Faulty construction with PEX has much more opportunity to go undetected at the time of installation. While an improper joint may fail during the system pressure test, exposure to solvents or the wrong type of firestop is more likely to appear as a catastrophic rupture a few years into service.

[5] DEIR p. 4.2-10

Service Life Predictions

The first point to note in plastic pipe survivability is that, unlike copper, there is no actual service history that demonstrates lifetimes matching expected building life. Furthermore, the longest life experiences are in European applications where arguably the environmental conditions, specifically chlorine exposure, are not the same as expected in the State of California. Service life of currently produced PEX pipe is based on testing to NSF (P171CL-T or P171CL-R) and ASTM (F2023) standards. These are all accelerated tests where lifetime predictions are mathematical extrapolations of short-term test to failure data. I have two concerns regarding these predictions. First, accelerated tests inherently assume that there are no separate time dependent reactions that alter the material in a manner not captured during the accelerated testing time frame. A particular example is consumption of stabilizer by oxidants such as chlorine. The accelerated test might measure the time to material embrittlement and failure upon consumption of the stabilizer package. However, as was apparent in the Flexet resin used in the Plasco Lot 7 product, the stabilizer package was lost not due to consumption but through leaching out of the plastic – that is how this material could pass the NSF test yet fail in service. Second, the validity of extrapolated results depends on whether all reasonable service variables have been addressed. In particular there is an issue of UV exposure in PEX. I have seen no standard that addresses UV exposure effects on lifetime. Manufacturers typically label their product with a limit on UV exposure, but current standards do not require longevity testing of the product after the limiting allowed UV exposure. This point is also made in a submittal by Lubrizol, a major manufacturer of resins for PEX production.[6] The Lubrizol letter also makes clear that there is no manner that UV exposure of PEX piping is or can be monitored throughout the production, transport and application process; one simply does not know the starting condition of the product at the time of installation.

Assumptions in the DEIR

It is my opinion that the DEIR is too willing to rely on the expertise of the construction industry to justify "less-than-significant" findings in expanded use of PEX.
The fact that PEX is susceptible to UV degradation has been public knowledge for many years, yet in my forensics practice I still encounter UV based failures of the product. Likewise, there are numerous instances when I have encountered PEX installations where there have been firestop incompatibilities. At a recent project we encountered four different PEX materials from three manufacturers and two different firestop materials, not associated with a particular PEX. This was at a Washington State townhouse project where the installing contractor was well aware of Plasco Lot 7 issues (having been involved in the litigation) at the time of construction. Another example deals with CPVC (chlorinated polyvinyl chloride) piping, but makes a point. There have been at least two separate major incidents (e.g. requiring nationwide recalls) involving different

[6] Letter to Ms. Valeria Namba, Senior Environmental Planner, California Department of General Services, Nov. 28, 2007, authored by Christopher Boyher, Lubrizol Advanced Materials, Inc.

products/producers were restraining devices have chemically interacted with the CPVC leading to rapid failures. These products were originally utilized to restrain metal pipe; they were then placed into service by experienced plumbing companies to provide the same function on CPVC. In one case the vendor developed a 'fix', to wrap the CPVC with aluminum foil, also mentioned in the DEIR in association with firestopping. In actual applications where I have been retained for forensic analysis, the aluminum foil often didn't cover all the exposed area or there were tears during installation – both ultimately leading to pipe failures.

Another apparent assumption in the DEIR that I find perturbing is that PEX is somehow immune to degradation in chloramine treated waters. The relative effects of chloramine vs. chlorine on aging of PEX doesn't appear to have been adequately studied to support such an assumption. A very recent study by Jana Laboratories Inc.[7] found specifically that the failure mechanism for all three common disinfectants was identical. Also, while the study states that the 'relative test lifetimes for the three different oxidants at the test conditions vary by a factor of three' no data is provided to show the relative position of the oxidants; the tabular information leads me to postulate that the chlorine dioxide was the most aggressive in attacking PEX. The study concludes "Additional research is underway to further characterize the specific mechanisms for the different oxidants and confirm the applicability of the standard test methodologies in assessing resistance to chloramines and chlorine dioxide". I don't believe that the data is available for the DEIR to assume current testing for chlorine resistance is applicable to alternative disinfectants or to make a knowledgeable statement discounting degradation of PEX in chloramine treated waters.

One other finding in the Jana study was that pipe failures did not require through-wall degradation. The overall failure mechanism they ascribe to each disinfectant was "depletion of stabilizer at the inner pipe surface, oxidation of the inner layer, microcracking of the inner layer, crack propagation through the wall with oxidation in advance of the crack front and final rupture of the remaining ligament thickness resulting in ultimate failure."[7] This mechanism does not require through-wall oxidative deterioration of the pipe material but speaks to a selective local oxidation with crack propagation.

Summary

I hope it is obvious in the paragraphs above that it is my professional opinion that the DEIR allowing expanded use of PEX for domestic potable water plumbing is far from adequate to reach a conclusion of no substantial impact of this product on the people of

[7] "An Examination of the Relative Impact of Common Potable Water Disinfectants (Chlorine, Chloramines and Chlorine Dioxide) on Plastic Piping Systems Components", Jana Laboratories study for National Research Council of Canada and the Plastic Pipe Institute.

the State of California. I recommend that further evaluations be undertaken to assure that product introduced into the marketplace can truly be considered viable over the lifetime of residential and commercial structures as installed under realistic conditions, rather than assumed ideal conditions, and conditions that reflect actual challenges faced by the material during a reasonable expectation of service life.

Respectfully submitted,
Veritox, Inc. dba
GT ENGINEERING

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