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REAL ESTATE
SERVICES DIVISION

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Re: Adoption of Statewide Regulations Allowing the Use of PEX Tubing

This letter's intent is to place into the public record facts that should be considered by the State of California on the evaluation of PEX pipe as a product to be used for hot and cold potable water pipe in chlorinated and ultraviolet light exposed conditions.

My name is Chris Boyher and I am the Business Manager for Lubrizol Advanced Materials, Inc., responsible for Lubrizol's two PEX businesses. The first is Lubrizol's PEX compound business that Lubrizol invented and manufactures to be sold to PEX pipe manufacturers for their own branded PEX product. The second business is Lubrizol's own branded PEX pipe made from our own compound that we market and sell for use in chlorinated hot and cold potable water applications. Lubrizol has some of the finest-equipped and staffed research and development laboratories in North America. Lubrizol laboratories are ASTM accredited and have a staff of over 120 Ph.D.'s in chemical engineering or other plastics-related fields.

It has been Lubrizol's defined objective to scientifically understand the realistic performance requirements of all products it manufactures and sells. This holds true whether that product is supplied as raw material or is marketed and sold as a finished product such as PEX pipe.

In this document I want to bring attention to two specific points that are based in known weaknesses of PEX and its base material Polyethylene (PE). The two known degraders of PEX longevity are chlorine found in the water and exposure to ultra violet sunlight. Both of these PEX degraders are prevalent throughout the State of California in the distribution channel, installation and installed use of PEX pipe in potable water systems.

Polybutylene (PB), Polypropylene (PP), Polyethylene (PE) and cross linked Polyethylene (PEX) are all members of the Polyolefin plastics family. Polybutylene's ASTM standard has been deactivated by ASTM due to its non-viability in the North America market, due to past failures directly related to exposure to chlorinated potable water. PP water heater dip tubes failed 10 years ago due to exposure to chlorinated water delivered to the home. PB, PP and PEX are all products manufactured from the base material of Polyethylene (PE). PEX is PE that includes several additives to give it the ability to handle hot water under pressure. Each type (4) of PEX

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has differing amounts of a chlorine anti-oxidant additive included in the compound prior to extrusion of the pipe. Chlorine is an oxidant. The chlorine anti-oxidant additive included in the PEX base compound is consumed by exposure to chlorine (oxidant) in California's chlorinated potable water. Chlorinated water is reintroduced to the piping system each time the water is turned on by a California resident.

All Polyolefin products degrade when they are exposed to chlorinated water. This degradation of material's (pipe) life expectancy is accelerated by heated chlorinated water. The hot water side of a piping system degrades faster than the cold side of the piping line, the same mode of failure that occurred with Polybutylene (PB).

Polybutylene (PB) is still being used in a many parts of the world for hot and cold potable water applications because those parts of the world don't rely on chlorine for the purification of their water. Countries that don't chlorinate their potable water use ozone, reverse osmosis, carbon or ground well systems. There is a direct scientific connection between chlorinated water and Polyolefin based materials decreased performance and longevity.

California's water distribution purveyors add chlorine to their potable water. California should consider requiring a level of chlorine performance for all approved PEX pipe products. A PEX pipe required chlorine performance level would ensure a realistic protection for performance and longevity of PEX pipe in all California PEX applications.

California has an increasing percentage of residential plumbing systems that are plumbed for potable hot water recirculation applications. This "hot water recirculation" means that there is a periodic or continuous movement of hot water on the hot water side of the plumbing system so the user doesn't have to wait for hot water when turning on the faucet. Hot water recirculation systems are considered "Green Building" applications. Virtually all hotels, hospitals or other high tenant use building use hot water recirculation systems.

The PEX industry has done an inadequate job of acknowledging and addressing the known weakness of PEX pipe when exposed to typical U.S. potable water system chemical composition. Our drinking water is chemistry; hydrogen, oxygen, purification (chlorine) additives, etc. When PEX representatives state that PEX has a 35+ year successful history in potable water applications, they are talking about the product history in Europe where little chlorine is used.

There are three levels of chlorine testing available to every PEX manufacturer today. The first chlorine test was created by the National Sanitation Foundation (NSF), an independent, third party testing laboratory that national, state and local codes refer to when approving products in their plumbing codes. The State of California recognizes and utilizes NSF's independent third party testing and verification of product approvals throughout its plumbing code.

NSF created NSF P171 chlorine protocol to allow PEX manufacturers of compound and finished pipe to have their materials and PEX pipe tested to two levels of chlorine protection. Each of these levels use the accepted industry standard 0.5 design factor (confidence factor, safety factor) so there is a built-in level for unexpected but potential increases in the given applications tested factors. All tests conducted by ASTM on all other piping materials when a design factor is appropriate use a 0.5 design factor.

The first applicable level for the State of California plumbing installations is NSF P171 CL-R. NSF P171 CL-R stands for 100% hot water CL-Recirculation. This test has taken into consideration worst case but a real level of chlorine found in water supplied to California residents. The NSF extrapolated test data identifies PEX pipe brands that achieve the independent test of NSF P171 CL-R with a 40 year expected product life. This NSF P171 CL-R test uses a 0.5 design factor so without the design factor has an 80 year service life expectancy. This NSF P171 CL-R test is available to all manufacturers of PEX compound and PEX pipe and those products that pass this independent third party test can be viewed on a daily updated site found at nsf.org.

NSF P171 CL-R

NSF Chlorine Testing	Service w/o Design Factor	Design Factor (a)	Service with Design Factor	Maximum Application Conditions
NSF P171 CL-R Recirculation	80 years	0.5	40 years	100% @ 140°F

The second level is also available through NSF and its nomenclature is NSF P171 CL-T or TD. The T (or sometimes written as TD) represents Traditional Domestic hot and cold potable water applications. Each of these levels use the accepted industry standard 0.5 design factor (confidence factor, safety factor) so there is a built-in level for unexpected but potential increases in the given application's tested factors. Traditional domestic hot water application is such that when you turn on your hot water side of the faucet and you wait until all the cold water is purged from the hot water lines to allow the hot water from your heat source (water heater) to exit the spout of the faucet. This is calculated and tested by NSF as 25% hot water and 75% cold water use of the hot water side of the faucet. The 25/75 is an average of 100% of the time hot water side of the faucet is used for actual hot water. Over 20% of the State of California's energy expense dollars are spent on moving water around the state to the point it's needed. Hot water recirculation systems save water, which saves the State of California money.

NSF P171 CL-TD

NSF Chlorine Testing	Service w/o Design Factor	Design Factor (a)	Service with Design Factor	Maximum Application Conditions
NSF P171 CL-TD	80 years	0.5	40 years	25% @ 140°F 75% @ 73°F

The third level of chlorinated water testing is contained inside of ASTM F876 PEX pipe standard and it's known as ASTM F2023. The ASTM F2023 test for chlorine resistance of PEX pipe has no design factor. The ASTM 2023 is the only test for any piping material that I can find that doesn't utilize the industry accepted standard of a .50 design factor. The ASTM F2023 testing only considers a traditional domestic application of 25% hot and 75% cold water with no design factor. The ASTM F2023 doesn't consider that a hot water recirculation system exists anywhere. This low level of test requirement for all PEX pipe to pass was voted and passed by the PEX manufacturers themselves. A stricter more realistic testing for the real and known conditions of chlorinated potable water PEX piping systems in the U.S. needs to exist inside of the ASTM 876 PEX pipe standard. As of now NSF P171 CL-R is the best and most application-realistic test for PEX pipe products to quantify PEX pipes performance and longevity in California chlorinated potable water piping applications.

The ASTM F2023 testing doesn't use a typical .50 design factor and has extrapolated test data of 50 years. The design factor is nothing more than a mathematical component to the extrapolated test data of expected product life. Take the ASTM F2023 documented 50 years and apply the industry accepted .50 design factor and PEX only has an expected service life of 25 years, five years less than the traditional home loan.

ASTM F2023

Standard	Service w/o Design Factor	Design Factor (a)	Service with Design Factor	Maximum Application Conditions
ASTM F2023 TD Only	50 years	None = 1.0	50 years	25% @ 140°F 75% @ 73°F
ASTM F2023 TD Only	50 years	.50 If applied	25 years	25% @ 140°F 75% @ 73°F

The second scientific and known weakness of PEX is ultraviolet (UV) light and the negative affects UV has on PEX pipes physical and performance characteristics resulting in reduced longevity for its intended application of potable water piping.

Ultraviolet light affects all materials in some manner. Windows and windshields of vehicles are tinted dark to minimize the amount of harmful UV "A" and "B" rays that fade colors and cause plastics to lose their supple and flexible nature among other performance characteristics.

The concern of exposure of PEX to UV has nothing to do with the heat generated from the sun, which is a partner in UV. PEX pipe is rated for 160 degrees and above so issues associated with PEX pipe have nothing to do with elevated temperatures. It's the exposure to ultraviolet A and B rays that is detrimental to the stability and performance of PEX pipe.

Each PEX pipe manufacturer has a written statement or warning concerning the amount of time their brand of pipe may be exposed to UV before their warranty is voided. After their specific brand of pipe is exposed to that amount of UV then their warranty is null and void. The unknown factor is no one knows how long a piece of PEX pipe or a coil of PEX pipe has been exposed to UV throughout the distribution channel that the pipe travels. No guidelines exist for UV protective packaging for PEX pipe. PEX pipe can be transported by an open air flatbed truck that allows UV exposure of the PEX pipe. A flatbed truck may unload the PEX pipe at the wholesaler who then may store the PEX pipe outside in their yard, again exposed to UV. PEX pipe is purchased by the plumbing contractor and the pipe is placed in the back of an open truck for a day, week, month or longer until all of the PEX pipe is used. The PEX pipe is installed in a house where the UV blocking walls might not be installed for days, weeks or longer. This accumulated time all counts against the warranty.

Some specific PEX manufacturers written statements concerning UV exposure of their brand of PEX are; Uponor PEX is 15 or 30 days depending on which public document you review. Rehau PEX voids their PEX pipe warranty after 15 days of exposure to ultraviolet light. Zurn makes a written statement, "Excessive exposure to UV light will void the Zurn warranty". What is "excessive exposure?" FlowGuard™ Flex carries a six month exposure to UV warranty.

PEX pipe exposed to UV is harmed in two distinct ways, affecting physical and performance capabilities. The first, PEX pipe loses its physical properties and attributes seen in loss of flexibility; color fade, print line fade, reduction of bend radius and pipe kinking occurs. The second is seen in the depletion of long term chlorine performance because UV depletes "off-gasses" the chlorine anti-oxidant additive package added to PEX that gives PEX its resistance to chlorinated water applications. The more UV PEX pipe is exposed to, the greater the amount of chlorine anti-oxidant additive package that is depleted, lessening PEX pipes protection against chlorinated potable water systems. Hot water increases the aggressiveness of chlorine in water. Hot water recirculation systems further increase the aggressiveness of the chlorine in the water, which degrades the chlorine protection added to the PEX pipe that decreases the PEX pipes longevity.

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The State of California has accepted the responsibility of deciding what is best for its citizens while balancing the economic impact of its decisions. The fact is that there is a significant percentage of single family, multi-family, hotel and commercial construction that uses hot water recirculation application for the water deliverance. The State of California uses primarily chlorine for water purification. The State of California's chlorine use in Parts Per Million (ppm), in its potable water has increased year after year for the last ten+ years. The State of California uses more energy for the delivering of water to its citizens than any other single energy expense. The State of California should only approve PEX pipe that can pass an independent third party test of NSF P171 CL-R for the known applications that exist in its plumbing code.

Some PEX pipe brands will not warranty their product for hot water recirculation systems. Approval of PEX pipe with anything less than NSF P171 CL-R would place the responsibility of the individual California inspectors to verify that every potable hot water recirculation system in the State of California uses only NSF P171 CL-R rated PEX pipe. The State of California has the authority of only allowing PEX pipe that meets the NSF P171 CL-R independent third party rating for all applications. This type of material approval would ensure that every piece of PEX pipe is rated for the worst case chlorinated water scenario.

Any PEX product approved without requiring the strictest testing available today would allow PEX pipe to have only ASTM F2023, which only test for 25 years (with 0.5 design factor) of service life with no use in hot water recirculation applications. Polybutylene (PB) passes ASTM F2023 and it failed miserably in U.S. water conditions. History of PB can be used when considering the future of PEX in the State of California plumbing code. I urge the State of California, the steward of protecting its citizens to rely on science and real-case scenarios such as chlorinated water and UV exposure when considering PEX pipe for use in the State of California.

Sincerely yours,



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