Comments of

COALITION FOR SAFE BUILDING MATERIALS

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

on the

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

VOLUME VI

APPENDICES TO THE COMMENTS OF
ADAMS BROADWELL JOSEPH & CARDOZO:
(Tom Reid Comments on 1998 EIR and Attachments)

April 22, 2005

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August 27, 1998

Mr. Dan Cardozo
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Dear Mr. Cardozo:

I enclose Thomas Reid Associates' comments on the California Department of Housing and Community Development June 30, 1998 Draft Environmental Impact Report for Chlorinated Polyvinyl Chloride (CPVC) Pipe Use for Potable Water Piping in Residential Buildings (SCH 970820040). My professional practice is preparation of EIRs and other environmental documents for state and local government and review of environmental documents prepared by others. My experience with CEQA dates to 1972 and my experience with the HCD plastic pipe approval process dates to 1980.

Our comments address major deficiencies in the EIR's definition of the proposed project, alternatives, and mitigation. Because the EIR relies heavily on NSF International standards as a substitute for the state's own investigations, we offer a thorough discussion of the NSF procedure and its limitations in application to the California CEQA process. We go on to discuss other inadequacies in the EIR treatment of water leaching and public health and in the environmental areas of solid waste, energy, fire, and socioeconomics.

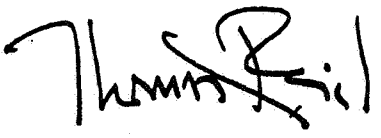
The 1998 draft EIR appeared nearly a decade after an earlier, uncertified draft EIR. That older EIR and the technical studies that went into it identified several important gaps in technical knowledge, and since its publication in 1989, several additional health and environmental issues have emerged. In reviewing the 1998 draft EIR, it is disappointing that the state did not take advantage of the intervening years to procure information capable of resolving these issues. It is particularly disappointing that the state did not demand from industry information on CPVC formulation, leaching, and NSF test results that industry maintains unpublished, but which are essential to the state's capacity for independent review.

These comments are a criticism of the 1998 draft EIR; where possible we have indicated steps that HCD should take to more accurately and objectively convey information for public review. At present the draft EIR is a non-quantitative narrative based on selective information submitted by B.F.Goodrich and a cursory review of old studies that led HCD to dismiss potential impacts. This dismissal seems to be an internal HCD process – the public is not given enough information to be able to the see how the conclusions were reached and it is difficult for the public to be able to meaningfully comment on those conclusions.

When HCD concludes that all impacts are either insignificant or unsubstantiated, it misses a real opportunity to define controls and conditions of approval of CPVC that would allow California to mitigate and monitor the health, safety, and environmental impact of plastic pipe. Throughout the lengthy state approval process for plastic pipe there has been a steady evolution in our understanding of a range of issues, and we have seen real improvements in both metal and plastic plumbing systems: lead solder has been banned, DMF has been banned from solvents cements, low VOC adhesive rules are in place, and manufacturing processes for plastic resins have changed. We have seen polybutylene (PB) enter and depart the North American plumbing marketplace and leave no mark on California.

This evolutionary process is not complete. Real environmental issues still surround the adoption of CPVC plastic pipe, but the EIR ignores or belittles them. HCD has an opportunity and an obligation to address these issues; HCD has a responsibility to put California in a leadership position for worker and consumer safety. With the 1998 draft EIR, HCD has failed.

Sincerely,



Thomas S. Reid

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1. Introduction

A. Inappropriate Advocacy Tone

The HCD document is structured as a draft EIR but is deficient in terms of CEQA content and CEQA practice. While it is not uncommon for a lead agency to act as a project proponent, this EIR is unusual in its vigorous advocacy of plastic pipe. The EIR acknowledges that B.F. Goodrich, the primary CPVC resin supplier in North America, is the major source of information used by HCD in drafting the EIR. Unfortunately this extensive reliance on B.F.Goodrich prevents HCD from conducting the independent analysis required by CEQA. This reliance also prevents HCD from aggressively seeking out information which leads to alternative conclusions from the advocacy positions so clearly stated in the June draft EIR.

The June HCD document itself is well-written and clearly sets out HCD's policy objectives. It seems as if an editorial decision was made to eliminate contradictory information that might potentially detract from the clear policy statement. Except for the rather elaborate excursion into the perils of copper pipe, the draft EIR is remarkably lacking in analysis and documentation. Most of the statements regarding impact in the draft EIR are conclusory, lacking quantification and lacking substantiation. The abundant footnotes often point only to shallow or incomplete references, often provided by B.F.Goodrich.

A further matter of tone, apart from the advocacy, is the authors' apparent belief that the Lead Agency's proposed action does not warrant an EIR under CEQA. After all, the EIR is being prepared under order by the court (Superior Court of California, County of San Francisco, Judgment Granting Peremptory Writ of Mandate, Case Number 977657, March 13, 1997.) In many places, the authors seem incredulous and even offended that the CEQA process is being undertaken at all. For example, in explaining its inability to estimate future CPVC use, the EIR states,"other than in California CPVC pipe itself is simply an item of commerce which has never been independently regulated, other than through the Uniform Plumbing Code. (P. 2, emphasis added) Certainly the EIR sees the approval of CPVC for this specific application to be a logical step in a grand scheme: "In a sense then, the proposed Regulations to allow the use of CPVC pipe for potable water pipe in residential buildings are part of a much larger societal trend: The replacement of traditional, often natural materials produced at great environmental cost, with man-made products." (P. 3)

B. Inadequate Technical Information

The document is so dependent on B.F. Goodrich as a source of information that the EIR takes on the tone and flavor of a marketing piece. This is particularly troubling because B.F.Goodrich undoubtedly has information under its control (e.g. NSF) which the state could have used in preparing the EIR, but which B.F.Goodrich elected not to disclose and which HCD refrained from requesting.

The EIR presents no new information. It presents no studies, either conducted by the state or by industry. The EIR relies almost entirely on a vague recitation of the earlier, incomplete 1989 EIR, without re-presenting the substantive analysis of that earlier document. Because it offers only a summary of the older EIR, the current HCD document fails to explain the limitations of

the older studies and presents a misleading account of the state of knowledge on plastic pipe. Given the time that has passed since the original draft EIR, it is hard to understand why HCD would not have undertaken at least some technical analysis of the wide range of pending issues concerning use of CPVC for potable water systems..

There are numerous potentially significant impacts associated with HCD's proposed action. These potential impacts have been identified during public scoping and in comment on the earlier draft EIR -- but the EIR either dismisses the issues with scant analysis or ignores the issues altogether. In many of these areas, the draft EIR faced a difficult task because information is incomplete. The EIR should have acknowledged the inadequacy of the decision making basis and attempted to obtain new information to acknowledge the uncertainties. Instead, the EIR merely comes to a conclusion that there is no evidence for potential adverse impact.

There are many examples of this. One is the EIR's dismissal of the recent awareness of potential carcinogenicity from Tetrahydrofuran (THF). Another example is the EIR's omission of any discussion of the adequacy of gloves to reduce worker exposure to solvents. This cavalier dismissal of problems with plastic pipe contrasts with the EIR's treatment of copper pipe. Without acknowledging our vastly longer history with copper piping, the EIR raises health and environmental impact questions about copper pipe in an effort to offset or counter balance the EIR's inadequate discussion of plastic pipe. Indeed, the EIR authors seem genuinely disappointed that lead is no longer associated with copper based plumbing, because lead's obvious toxicity simplifies the policy determination that the EIR is attempting to make.

The EIR seems to follow the following logic: 1) there are questions about CPVC pipe for which we don't have all the answers, but there is nothing obviously terrible about plastic pipe; 2) we can identify health questions about copper pipe as well; 3) the fact that questions have been raised about CPVC is not a reason to forbid its use in California. The problem with this logic is that it ignores the state's CEQA obligation to fully investigate the nature of the questions regarding CPVC pipe and to make a good faith, independent, and objective effort to answer those questions prior to the state proceeding to act.

The following technical discussion illustrates these particular failings. We present some new information gathered over the past few months. This includes preliminary laboratory work and recent publications. We also include technical analyses of several subject areas that the EIR ignores.

The EIR authors may view these comments as unnecessarily technical and may consider the issues raised as irrelevant to a decision which the Lead Agency seems to have already made. In fact, the issues raised here are essential to the state's decision. Approval of CPVC pipe for potable water in California will presumably lead to construction of new homes with CPVC plumbing. That plastic plumbing will be an essentially permanent component of the environment; if there are health, safety, or environmental impacts of that plastic plumbing, it is only common sense and responsible government to clearly identify problems and practical mitigation in advance. Given the scanty technical analysis in the 1998 draft EIR, the Lead Agency does not posses adequate information to proceed with the decision-making process.

The EIR attempts to rationalize this deficiency when it states: "To the extent there may be some unknown risks, the known benefits of a greater choice of building materials outweigh those risks." (P. v) This document clearly shows that the state has not made a good faith, objective effort to make known the "unknown" risks.

2. Incorrect Statements of Existing Code and Usage

The EIR includes several glaringly incorrect statements that affect the accuracy of the project description and the definition of alternatives. Incorrect statements regarding approval and use of CPVC in other states or for public water supply invalidate the EIR definition of both the existing environmental setting and the effect of the No Action/No Project alternative. The EIR addresses copper pipe both in the No Project and in other alternatives. Incorrect statements about the regulatory status of copper pipe invalidate EIR treatment of those alternatives.

A. Incorrect Statements of the Applicable Plumbing Code Sections Subject to Lead Agency Action

According to the Proposed Code Change in the EIR's appendix (p.5), the project under consideration by HCD is Section 604.1 of the UPC and the addition of two provisions related to the use of CPVC. The wording of these "two provisions" is not provided. The reader must go through the various codes and standards presented in the Appendix and determine exactly what would be adopted. It is not clear that this code adoption takes into account the full extent of all the appropriate standards that are referenced in the UPC.

Relevant sections of the 1995 code have been left out of the appendix such as: **"316.1.5 Solvent Cement Plastic Pipe Joints.** Plastic pipe and fittings designed to be joined by solvent cementing shall comply with appropriate IAPMO installation standards....CPVC and PVC pipe and fittings shall be cleaned and joined with listed primer(s) and solvent cements." Why was this very relevant section left out of the EIR appendix?

Further, the inclusion of the 1995 Plumbing Code (p.10) and the 1993 Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems (p.29) does not even take into account the most up to date 1997 UPC. The 1997 UPC will be shortly adopted as the 1998 California Plumbing Code (CPC). Since this project will be implemented using the 1998 CPC, this is the code that should have been cited in the appendix. There have been changes in the UPC since the 1995 CPC was adopted. For example, the Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems in the EIR appendix IAPMO IS 20-93 (p.29) has been updated as IS 20-96. IS 20-96 requires that primer be used whereas IS20-93 does not: **"316.1.1.3 Primer.** A listed primer in compliance with ASTM F 656-93 shall be used on all CPVC solvent cemented joints."

Why would the EIR refer to codes that will be outdated by the time the project comes before the Building Standards Commission for approval?

B. Misstatements Regarding Existing Use in California

The EIR claims that, "CPVC and its parent polymer PVC are approved for use in public water supply systems. Therefore, the existing environment of potable water piping in California includes CPVC in the supply systems ..." (EIR, p.20) While it is true that the UPC permits the use of CPVC pipe in public water supply systems, CPVC is in fact <u>not used</u> and therefore it can not be considered as part of the existing environment as the EIR states. The EIR authors assume that since CPVC is

part of the existing environment that the impacts of adding additional CPVC are not as great, however this is simply not true.

CPVC is not used in public water supply distribution in California. The following California water districts were surveyed by telephone in August 1998: San Francisco Water Department (Bruce Hubley, Distribution Dept.), East Bay Municipal Water District (Pat Clinton, Distribution Dept.), Los Angeles Division of Water and Power (Kenneth Mak, Engineering Dept.), San Diego Water Utilities Department (Myrna Dayton, Engineering Dept.) and Coachella Valley Water District (Jim Zimmerman, Service Dept.). These districts cover the largest urban areas in California: San Francisco Bay Area, Los Angeles and San Diego and one southern central valley district. In addition, the chair of the California Chapter of the Water Distribution System, American Water Works Association, was interviewed about piping materials used in California in water distribution systems.

None of these five water districts use CPVC in their water distribution system, generally because PVC is less expensive. In addition, the chair of the California Chapter of the Water Distribution System, American Water Works Association, has never heard of CPVC being used in water distribution systems in California (Robert Clark, Capistrano Valley Water District).

Of these five districts, only the San Diego Water Utilities Department and the East Bay Municipal Water District use PVC in water distribution. Pat Clinton, Distribution Systems Engineering, EBMUD, (pers. comm., 8/20/98) estimated that in it's new installations, East Bay Municipal Water District (EBMUD) uses about 66%- 75% PVC, the remainder of the piping material is steel.

When PVC is used, it is typically not glued together, but it is mechanically joined by a push fitting with a rubber gasket or ductile iron fittings with no glue or solvents cements involved. Occasionally, small diameter -- 2 inches -- PVC pipe is solvent cemented, but the circumstances requiring only 2" diameter piping are infrequent, since fire protection fire flow requirements now require a minimum of 6" diameter pipes for adequate pressure.

The decision to use PVC pipe or steel in EBMUD takes into account size (pipe diameter) requirements, whether the installation site may have subsurface toxic contamination, slope of the site, landslide potential, crossing fault zones, and anywhere there would be high property damage if the pipe failed. PVC is used for 2" - 8" diameter installations; steel pipe is used in 6" - 12" diameter and greater. PVC will not be used if there is a potential of permeation from contaminants such as hydrocarbons from former gas station sites or pesticides from former agriculture sites. PVC is not used where the grades are steeper than 15% because only pipes materials with restrained joints are allowed. On steep slopes, steel welded pipes are used because they are restrained joints that will not burst under pressure. PVC pipe fittings will blow off under pressure. PVC will not be used in areas that cross fault zones because it can't take the shear stress from fault movements. When PVC fails it is a catastrophic event because it ruptures completely, whereas steel may just spring a leak that can be fixed by welding. Therefore any area that would suffer costly property damage due to a pipeline rupture (e.g. homes downslope of a pipeline), steel is used as a precautionary measure.

This finding from this survey is in sharp contrast to the EIR's assertion that CPVC pipe, as

defined in the EIR for the purposes of the proposed action, is already part of the California environment because of its use in public water supply distribution. The "CPVC pipe" project under study in the EIR is solvent-cemented, small diameter CPVC. The pipe used in public water supply distribution is sometimes plastic, never CPVC, and practically never solvent-cemented. Because of this fundamental error, the EIR authors may have been led to incorrectly conclude that the absence of public health concerns over leaching from plastics from public water supply distribution in California meant that there were no legitimate analogous concerns for CPVC use in residential installations.

C. Misstatements Regarding standards for metal pipe

In an attempt to disparage metal pipes, the DEIR makes several misstatement about the standards for metal pipe. The DEIR states, "By way of contrast while there are established standards, tests, and certification for the health effects of CPVC pipe, at the time of writing this EIR there are no such requirements for metallic pipe and fittings. The Lead Agency is not aware of any assessment of the potential health risks presented by trace contaminants of copper in potable water pipe" (Footnote 9, p.7). This statement is incorrect because there are established standards for metal pipes. NSF 61 addresses metal pipes as well as ASTM and AWWA standards. In the same way, ANSI/NSF 61, Section 9 approves metal fittings.

The DEIR states, "...It is important to note that at the time of writing this EIR, independent testing and certification to established standards is not required for metallic pipe used for potable water systems in residential buildings" (Footnote 10, p.7). The DEIR also states, "By way of contrast metallic pipe used for potable water piping in residential buildings in California is not subjected to NSF or other independent testing for safety or suitability; instead it is self-certified by the manufacturer as meeting standard specifications, which relate to physical parameters of the pipe and fittings and do not include water contamination criteria or testing for safety" (Footnote 21, p.17). This statement is incorrect because the UPC requires that copper pipe used in water service meet ASTM standards which includes a testing and certification process.

The text of the EIR must be changed to reflect the UPC's requirement that copper pipe meet ASTM standards and omit all statements that metal pipe does not need to meet any standards for safety or suitability.

D. Misstatements Regarding Lead In Copper Plumbing Systems

Another systematic error affecting the EIR definition of the environmental setting and the No Action alternative is the lingering confusion over the extent of lead which will leach from a copper pipe system installed under current building codes. Lead solder was banned in 1986 in California; approved solder contains less than 0.02 percent lead. Copper pipe itself contains a negligible amount of lead (<10 ppm, CH2M Hill, Aug 1987, HCD-82, P. I-3). The EIR includes an unsubstantiated and speculative statement, "The extent to which high lead content products are still used despite the codes and labeling is open to question. <34> {Katz, E. 1998. Letter w/3 attachments. 3 pp. HCD } It is a certainty that the low lead solders and brass foundry products still contribute some lead to tap water. " (P. 33) and "This includes the concern raised by DHS <71> regarding the apparent continued use of lead-based solders by installers of copper pipe. " (P. 69) Reference to the Katz, DHS letter shows it to be based on a phrase in a 1989 report (Bellows)

describing lead solder in the tool boxes of plumbers observed during a worker safety survey. That survey was conducted in 1988 outside of California, not long after the federal lead solder ban. The presence of the solder does not mean it was being used.

HCD's EIR is being written in 1998, and HCD and DHS presumably have access to current information regarding compliance with the lead solder ban in California. Does the Department of Health Services have evidence that the state code ban on lead solder is being routinely violated? Has this information been made public and what is program of enforcement is in place? If the state has no such evidence, then the EIR should exclude these statements. Inclusion of this sort of incorrect statement biases the EIR analysis of the No Project alternative and leads the reader to question the basis on which the draft EIR findings are made.

3. Incomplete Project Description

A. Overview

The project description in an EIR is the key to adequate analysis of environmental impacts of a proposed action. In this case the project description fails in several important regards. The EIR

1. Presents an incomplete description of the plastic pipe system subject to expanded use upon lead agency action.
2. Presents an incomplete and non-quantitative characterization of CPVC pipe formulation.
3. Fails to address contamination of CPVC resin.
4. Fails to discuss the undefined characteristics of low VOC cement.
5. Fails to identify reasonably foreseeable actions which contribute to cumulative impacts.
6. Presents an incomplete and speculative definition of which mitigating measures are incorporated in the proposed project and how those measures are to be implemented.
7. Makes erroneous assumptions about the definition of the No Project alternative.

These deficiencies are disappointing because the need for this information was identified during the public scoping process. Without this information the EIR cannot adequately identify potential environmental impacts, nor can the EIR begin to quantify the magnitude of potential impacts.

B. The CPVC Plastic Pipe System in Residential Installations

Most Current Uniform Plumbing Code (UPC) Not Used

In introducing the project description, the EIR addresses the proposed code change (P. 1) by referring to the key paragraph on page i of the code and the expanded texts of the relevant code in the technical appendix. Relevant sections of the 1995 code have been left out of the appendix such as: 316.1.5 "... CPVC and PVC pipe and fittings shall be cleaned and joined with listed primer(s) and solvent cements." Inclusion of the 1995 Plumbing Code (p.10) and the 1993 Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems (p.29) does not even take into account the most current 1997 UPC. The 1997 UPC will be shortly adopted as the 1998 California Plumbing Code (CPC). Since this project will be implemented using the 1998 California Plumbing Code, this is the code that should have been cited in the appendix. Changes since the 1995 CPC was adopted include IAPMO IS 20-96 explicitly requiring that primer be used. Even recognizing that California's code adoption cycle necessarily lags the action of IAPMO, the EIR's use of already out of date material affects the accuracy of its treatment of solvent cements. Many of HCD's conclusions about worker safety and consumer health rely on the belief that solvent usage for primers and cements is lower than in the 1980s when the work for the earlier EIR was done. The EIR should list in a table the code changes that will pertain to health, safety and environmental impacts.

Manufacturers

That the primary source of information relied on by the EIR authors is clear from the references

and from the emphasis in analysis. Only B.F.Goodrich personnel are referenced in Chapter 11: Organizations And Persons Consulted, and the only industry citation in the EIR is to "B.F. Goodrich. 1997. Background Material for Consideration in Writing the EIR for CPVC Pipe in Residential Buildings in California. October 1997." (Footnotes 4, 52, and 53 or other footnotes referencing B.F. Goodrich documents). The EIR notes, " ... the Lead Agency has: ... considered ... information submitted by manufacturers of CPVC pipe, the plastics industry, ..." (P. 3), but the authors in fact have made no effort to identify manufacturers other than B.F.Goodrich that may make CPVC resin for the future California market. It is clearly insufficient to rely on B.F.Goodrich's dominance of the North American market. To do so is to fail to recognize the economic opportunities for plastic pipe manufacturers that will be created by the lead agency's action and to ignore the real potential for other manufacturers' products to be used in California. The EIR should list the half dozen or so major resin manufactures that may be seeking the California market place..

This omission sharply limits the applicability of the EIR's analysis and contributes to its editorial tone as a marketing document for B.F.Goodrich. By focusing only on B.F.Goodrich, HCD only requested information from B.F.Goodrich, and hence was not made aware of a broader range of environmental issues relevant to HCD's proposed project. These potential issues include the use of stabilizers other than organotins or manufacturing processes that may introduce chlorinated solvents or other contaminants. HCD brushes off the issue of other manufacturers by relying on the NSF approval process for products to be used in California. As discussed elsewhere this reliance is incomplete and unfounded, even as it applies to B.F.Goodrich products. When HCD fails to identify potential health issues for other manufacturers, HCD cannot analyze those issues in the EIR and it cannot show that all potential exposure is subject to testing by NSF, and hence has no basis for relying on NSF.

Range of CPVC Pipe Products

The EIR appears to focus on only a part of the range of products which would be permitted by the Lead Agency's proposed action. The draft EIR cites the UPC and its reference to CPVC "tubing". Reference to the list of manufacturers in the NSF certification document shows that there are flexible CPVC tubing products on the market. The EIR only describes rigid CPVC tubing as the basis of the potable water pipe system. Does the state intend to limit CPVC approval in California to only rigid CPVC?

Because slab-on-grade construction is common in California and contributes to most of the mass produced housing, the availability of a flexible, sub-floor installation material is economically important. Most copper piping installed in California is "soft copper" flexible tubing which can be routed around the structure with a minimum of joints. This is a labor saving feature that would be emulated in plastic and was one of the reasons why PB piping was recognized as having a market advantage over CPVC in the 1989 draft EIR.

In its dismissal of permeation risk, HCD states that there will only be CPVC in the structure and no CPVC in the ground. Does HCD believe that codes or good construction practice allow plastic pipe to be made with solvent joints and then be sealed beneath a concrete foundation slab? Does HCD exclude under-slab construction? If a flexible CPVC product is available it would be aimed at this market. However, the EIR neither identifies the availability of flexible CPVC nor does it describe the composition of flexible tubing or its potential for environmental

impact.

Hot Water Temperature

The EIR misstates the operating environment of potable water piping in California. In discussing suitability for use the EIR states, "Hot water in residences is 110° by California Building Codes. CPVC is suitable for water temperatures over 200°." (P. 5) Most domestic hot water applications for clothes and dish washing demand higher temperatures. Hot water heaters are sold in California with temperature settings well in excess of 110 degrees Fahrenheit. In fact, the Uniform Plumbing Code Section 502.13 defines a water heater as an appliance with controls limiting water temperature to a maximum of 210 degrees Fahrenheit. The EIR should be based on a realistic temperature range based on actual usage in residences. HCD should determine whether temperature settings on water heaters are intentionally made lower for CPVC installations to take into account the inherently lower temperature capacity of the plastic pipe system. Does the manufacture or any pipe extruder or installer make this recommendation?

Determining and accurately portraying the temperatures which will be faced by expanded CPVC installation is an essential component of the project description. The temperature on the hot water side is relevant not only to issues of consumer product reliability, but also to issues of public health and safety. It is widely acknowledged, even in the EIR, that chemicals will leach more quickly when exposed to hotter extractant water. The EIR authors dismiss the role of hot water leaching, believing that only cold water is used for drinking and hence will be the only mode of exposure, "These extraction tests are performed at elevated temperatures, and so the actual concentrations of organotins in drinking water would be lower than suggested by these test data. " (P. 39) Comments on public health (see Dr. Martin Smith and Ms. Peggy Lopipero) show clearly that inhalation and skin exposure during bathing are important for both solvents and for organotins.

Potable Water Pipe Environment

The EIR is supposed to address the full project: the code change which would allow CPVC pipe for residential installation. The analysis in the EIR, however, is limited to pipe installation in the walls and floors of the structures themselves, and omits consideration of the run of plastic pipe from the water meter or any under-slab construction. This narrow focus is illustrated when the EIR talks of permeation, "The proposed building standards apply to potable water piping in the interiors of residential buildings. ... It is difficult to imagine a realistic scenario where the potable water pipe in the interior of a residential building would be subjected to prolonged contact with very high concentrations of harmful materials, such as gasoline, capable of permeating the pipe. (P. 61) The residential installation begins at the water meter, which is usually installed at the property line or between the curb and the sidewalk. This will afford some 30 to 50 feet of in-ground exposure. As discussed above, the slab-on-grade style of construction is popular in California (where there is no frost-line), this would result in an additional 50 to 150 feet of ground exposure. The draft EIR omits this important component of the project. HCD should determine what extent of future installations of CPVC would be under-slab.

C. Pipe Composition Manufacture

The discussion of public health in the EIR is presumably based on the EIR's definition of CPVC pipe resin formulation set forth in the project description. The information provided in the EIR is incomplete and non–quantitative. Correct and complete information could have been readily provided by reference to published industry sources or from B.F.Goodrich.

Part of the trouble stems from the EIR failing to draw a distinction between the primary polymer manufacturer and the pipe extruders. How many different products are offered by the resin manufacturer? B.F. Goodrich alone offers several different pipe resins, with different polymers and additives. What additional compounds may be added by the pipe extruders when the resin is formed into the marketable product? Do extruders add additional stabilizer or lubricants to pipe resin?

In several places, the EIR authors show a lack of familiarity with the manufacturing process. For example, the EIR states, "In addition, the chemicals Chloroform and Carbon Tetrachloride are formed during the manufacture of PVC and CPVC resins and have also been detected in water during leaching studies." (P. 22) This statement ignores the fact that chloroform and carbon tetrachloride were deliberate additives in the manufacturing process for the pipes analyzed in the referenced leaching studies. Later, the EIR attempts to narrow its discussion of leaching to organotins and to "Products formed from the reaction of chlorine during the production of CPVC resin. The chlorine reaction products are addressed in the next section, Disinfection By-Products. This includes the chemical chloroform, which is not only formed by reaction with chlorine, but also can be used in the manufacture of CPVC resin. The Lead Agency does not consider the exact origin of a trace impurity to be particularly relevant to the potential for significant impacts from its presence. " (P. 33) This statement ignores the significance of whether a substance in the drinking water is deliberately included in the pipe manufacture or is a contaminant of the pipe or is formed in the water later.

If HCD believes that the halocarbons are formed by the disinfection process, does HCD believe that they will be formed by reaction with normal chlorinated water. Does HCD know if the compound would be detected by NSF's extractant process. If a contaminant is in the pipe, NSF might find it. If it is formed in usage, NSF would not. Thus HCD cannot ignore the distinction.

As discussed below there are other contaminants which may be formed in the chlorination of PVC which are not addressed by EIR.

CPVC Resin Formulation

The draft EIR describes pipe-grade CPVC resin on pp. 5 and 25. Only a narrative is supplied -- there is no identification of the actual chemical substances used, or their quantity. The EIR merely identifies, "Organotin stabilizers ... The predominant pigment is titanium dioxide ... The lubricants are paraffins, which are derived from petroleum, and derivatives of stearic acid, which is obtained from plant and animal fats. " (P. 25) The only polymer mentioned is chlorinated PVC, there is no mention of polymer additives or polymer modification to improve resin characteristics.

Given the EIR's reliance on B.F.Goodrich as a source of information and given B.F.Goodrich's

willingness to provide information (HCD-199 and HCD -227) it is remarkable that HCD did not at least include a full description of CPVC pipe resin as formulated by B.F.Goodrich. This information is not a trade secret. The NSF approval process relies on a standardized formulation of CPVC pipe, described below. B.F.Goodrich itself has provided formulation listing in patents which are readily available to the public (see Attachment B for examples of B.F.Goodrich CPVC patents: B.F. Goodrich CPVC patent No. 5,591,497; CPVC patent No. 5,194,471; and CPVC patent No. 4,377,459). The description of the "common art" of PVC is applied to the CPVC pipe formulations in great detail in No. 5,194,471 which describes a product quite more complex than the one contemplated by the EIR authors.

Because HCD does not list CPVC resin manufactures, it does not list different manufacturing methods that may affect the range of water contaminants. HCD notes that NSF seeks such formulation information, presumably because it is relevant to health issues, but HCD did not seek that information. Note that because of the use of a "range formula" discussed in comment Section 4, NSF may not receive anything more than a generic formulation from the manufacturers.

The issue of manufacturing is not academic. In the earlier leaching studies, high, unacceptable levels of chloroform and carbon tetrachloride were found. This contamination came from residual amounts of these chemicals that were used in the manufacturing process. Later changes in B.F. Goodrich PVC chlorination methods eliminated these material (Attachment B, Patent 4,377,459; 1983). This does not mean that other manufacturers do not use these. In one of its patents, B.F. Goodrich states that "CPVC can be made according to any commercial chlorination process or the like such as by a solution process, a fluidized bed process, a preferred water slurry process, a thermal process, or a liquid chlorine process. Inasmuch as chlorination processes for preparing CPVC resins are established and CPVC is readily available in the art, they will not be discussed in great detail herein." (Attachment B, Patent 5,194,471; 1993). HCD should inform the reader what this means for the proposed project.

Polymer Additives and Impact Modifiers

Polymer modification entails changing the nature of the CPVC resin by adding co-polymers or other polymers such as butadiene rubber. These polymer modifications are intended to add toughness or flexibility to brittle, stiff CPVC pipe. Is CPVC the only polymer present in pipe-grade resin? B.F.Goodrich mentions an "impact modifier" in its patents: "CPVC compositions, pipe, and a method of preparing a pipe are disclosed and comprise CPVC having 63% to 70% by weight chlorine and preferably 65% to about 69% chlorine; a high rubber impact modifier comprising a graft copolymer of a rubbery polydiene and one or preferably more than one hardening monomer selected from a group consisting of a vinyl aromatic monomer, a (meth)acrylate, and a (meth)acrylonitrile monomer including mixtures." and "13. An extruded chlorinated polyvinyl chloride pipe derived from a composition comprising chlorinated polyvinyl chloride having 65% to 69% by weight chlorine, a copolymer impact modifier comprising polybutadiene and having a Shore D hardness of from about 35 to less than about 64, chlorinated polyethylene, a stabilizer, an acrylic process aid and titanium dioxide" (see Attachment B: BF Goodrich CPVC patent No. 5,591,497)

One of B.F.Goodrich's premier products is called "Flow Guard Gold" which is touted for its greater impact resistance. Is there an additive to Flow Guard Gold to give it properties not

available in resins from competing manufacturers? If CPVC resin is characterized as "hard", does B.F.Goodrich need to modify the polymer in the resin to produce a flexible or semi-rigid tube?

Thermal Stabilizers

As pointed out by the EIR, thermal stabilizers are necessary to prevent degradation of the CPVC resin during extrusion and use (P. 25). Thermal stabilizers are used for both CPVC and PVC; the greater temperature resistance of CPVC compared with PVC is offset by the need to use even higher temperatures during resin extrusion. The tendency for vinyl plastics to lose mechanical and color qualities in manufacturing has great economic importance to the industry. The subject matter of thermal stabilization for PVC and CPVC is very broad and well documented.

Non-tin Based Stabilizers

Organotin compounds are by no means the only materials used as thermal stabilizers. Other heavy metals including lead are used for vinyl plastics and apparently for vinyl tube used for potable water.

Lead is probably the earliest and chemically possibly one of the most effective stabilizers for vinyl. Lead-based stabilizers are widely used in flexible PVC and outside of the United States are used for potable water tubing, as observed by Glenn R. Atkinson, in *Polyvinyl Chloride Processing Stabilizers: Lead and Its Derivatives*, "Although the use of basic lead stabilizers in rigid PVC in the United States is somewhat limited, throughout the rest of the world, their use in these applications is quite common. The fact that the markets developed differently over the past 30 years was due primarily to differences in extraction standards developed for determining the leachability of lead stabilizers from PVC potable-water pipe. National Sanitation Foundation (NSF) Standard 14, the original extraction method, was a much more severe test than International Standards Organization Standard 3114, the method used throughout the rest of the world. Recently, the NSF methods were changed to reflect the actual use of the pipe. In a study funded by the Lead Industries Association, it was shown that lead-stabilized rigid-PVC pipe can be formulated adequately to meet the new NSF Standard 61 requirements. (Editor's note: There is currently no indication that the National Sanitation Foundation is considering or will consider approval use of lead-based stabilizers in PVC pipe.)" Chapter 20 in Jesse Edenbaum, ed. Plastics Additives and Modifiers Handbook, Chapman & Hall, New York. 1996 P. 334.

This text is relevant to two aspects of the EIR. First it provides HCD information on an alternative stabilizer, lead, that was not evaluated in the EIR. It shows that potable water products are manufactured with this stabilizer and should be included in the project description. NSF does not prohibit CPVC pipe made with lead-based stabilizers. If these products can pass NSF 61, then they would be permissible in California, and any amount of lead leaching from these classic products would need to be appraised cumulatively with other forms of potable water lead exposure.

Second, the text points out how NSF 61 incorporation of the "normalization factor" to reflect "at the tap" exposure amounts to a relaxation of extractant testing rigor. This adds another dimension of uncertainty to HCD's reliance on NSF, because HCD must independently

determine that the NSF normalization factor is sufficiently protective of public health in actual usage in California and would result in potable water delivery in compliance with California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).

Apparently some vinyl tubing manufacturers do not share HCD's phobia of lead. According to the European Council of Vinyl Manufacturer's website (www.pvc.org) question and answer page (Attachment E):

"**Q** Why is lead used as a stabilizer? Isn't lead a poisonous material?

"**A** Lead is an abundant, naturally-occurring metal and PVC products have been stabilized with lead compounds since the early 1930s. Lead is the most important stabilizer for rigid PVC applications...Among the principal applications using lead stabilizer systems are long-life products for the construction sector such as pressure pipes for potable water transportation..."

HCD needs to determine what other stabilizers including those with heavy metals other than tin may be used for vinyl potable water products. In order to adequately disclose the realistic range of CPVC products which may be used in California once HCD adopts its proposed plumbing code change, HCD needs to examine commercially available stabilizers used for both CPVC and PVC.

Commercial PVC data is relevant to CPVC because of the chemical similarity and the history of commercial application of PVC additives to CPVC manufacture. When defining the applicability to the EIR, it states, " ... this EIR may also be of relevance to possible future projects involving plumbing materials and the use of plastics, especially CPVC and its parent material, PVC. ... the Lead Agency expects the EIR may be of some use in the preliminary review and scoping of future projects which have potentially significant impacts related to the use of CPVC and PVC for other purposes." (P. 6) In attempting to broaden its assessment of leaching, the EIR refers to PVC public water supply piping and justifies that inclusion by referring to "CPVC pipe and pipe made from the parent polymer PVC " (P. 34) However, in the project description, the EIR seems to offer nothing more than a narrow, colloquial depiction of B.F.Goodrich CPVC products, ignoring other manufacturers and ignoring the broader, more competitive PVC industry.

The European defense of the use of lead based stabilizers and the absence of any U.S. prohibition on their use in potable water pipe means that HCD cannot ignore the possibility of lead as a deliberate pipe resin constituent. As discussed below under contamination, a screening-level laboratory test detected lead in an aqueous extraction of B.F.Goodrich CPVC pipe (Attachment Q).

Organotins

Even within the class of organotins, there appears to be numerous formulations available for use. These variations include different alkyl groups bonded to the tin atom, different numbers of alkyl groups, and different bonding schemes for the organotin sub-units. While these different model additives will probably leach similar organotin compounds, the overall molecular structure may significantly affect the rate of degradation and migration of organotins from the polymer matrix. Use of different thermal stabilizers formulations by different CPVC resin manufacturers may

result in dramatically different organotin leaching rates into drinking water. Although there has been no systematic study of organotin leaching, the preliminary results from the most recent Sadiki study found that there appears to be variation between PVC pipe samples (Sadiki and Williams, "*A study on organotin levels in Canadian drinking water distributed through PVC pipes*", Health Canada). According to the results of PVC pipe sample extraction:

"Of theses [15] samples of PVC pipe, 12 contained monomethyl- and dimethlytin, 2 contained monobutyl- and dibutyltin and 1 contained a mixture of the four compounds with more butyl- than methyltins."

Lubricants

Lubricants used in the manufacture of CPVC are generally from the class of soaps or waxes. Because of their established effectiveness and low-cost, there appears to be little range of commercial substitution of products with a resultant greater potential public health impact. It should be noted that the residue of lubricants on the surface of the pipe contribute to the need to use a primer or cleaner prior to cementing a joint. Development of a "one-step" cement may be paralleled by changes in extrusion lubricants. B.F.Goodrich patent literature refers to lubricants which are acrylic.

Pigments

The EIR only mentions titanium dioxide as a pigment. As sold, CPVC for potable water use is colored with pigments other than titanium dioxide white. There must be other substances used as pigments, such as carbon black, iron oxide, or organic dyes. If the EIR authors have access to a listing of dyes or pigments, it should be included in the EIR for completeness. As it is, the selective and obviously incomplete listing of CPVC constituents demonstrates the inadequacy of the EIR project description.

Future Change

CPVC is an evolving product. Even over the course of the state of California EIR process, the manufacturing methods and formulation of CPVC for potable water use has changed. The HCD EIR acknowledges the likely changes in the future without identifying the nature of these changes and tbe possibility that new potential leachates or contaminants might result. While it is laudable to instruct NSF to be aware of future formulation changes, the EIR is inadequate without at least a preliminary consideration of the nature of these changes and as discussed elsewhere in these comments, the NSF process cannot ensure that significant impacts on public health will not occur. How does HCD expect to keep track of future changes? Does the state need to be able to continue monitoring future changes in the plastic pipe it plans to approve?

Based on patent literature, we expect changes in formulation for CPVC to occur due to different manufacturing processes (PVC chlorination), different additives (stabilizers, etc.), and polymer modification. To ensure the protection of public health and safety, the EIR should establish review procedures for the use of new formulations of CPVC .

D. Contamination of CPVC Resin or Pipe

As with any industrial product, CPVC resin is subject to contamination by unwanted chemical substances. The contamination can come from several sources: impurities in starting materials, or reacted or residual starting materials, and substances created during the manufacturing process or added in extruding resin to make pipe.

Trialkyltin

One class of deliberate additive is thermal stabilizers. The EIR claims that tributyl tin oxide (TBTO) is not added to CPVC resin. " TBTO is not added to CPVC. The organotins used as stabilizers in CPVC are far less toxic than TBTO. ...The highly toxic organotin TBTO is simply not present in CPVC. (P. 40) If the EIR had included a more thorough discussion of thermal stabilizers it would have shown the reader that the alkyl tins are breakdown products from the stabilizers and in these forms are not added to CPVC either. The EIR should also have included the literature reference to the relationship between alkylation number and value as a thermal stabilizer. This would have shown that the objective for an organotin stabilizer is to provide dialkyl or mono-alkyl tin in preference to tri-alkyl tin, combined in a larger molecule.

Whenever alkyl tins are found leached into water, it is because those molecular fragments have been released from the original formulation. Thus, it is not a matter of whether TBTO is deliberately added to CPVC, it is a matter of whether tri-alkyl tin is present as any constituent. The commercial manufacturing process for alkyl tins begins with a fully organic substituted tin – tetra alkyl tin – which is mixed with an inorganic reactant, usually chlorine, to lower the alkylation number. Thus in producing a mixture of mono- and di- alkyl tins, there will be incompletely reacted trialkyl tins left as a contaminant.

Because the EIR does not examine the actual thermal stabilizers in use for vinyl plastics, it is not surprising that it also does not seek to determine whether tri-alkyl compounds could be present. There is evidence that tri-alkyl compounds can appear in pipe resin and in water, albeit at far lower concentrations than for the mono-and di-alkyl forms. According to the Sadiki study on organotin leaching from PVC pipes, tri-methyl tin was observed leaching from PVC pipes at a level between 0.5 and 1.0 ng Sn/L (HCD-334, p.2396).

In a laboratory test conducted for Thomas Reid Associates, CPVC pipe turnings were extracted with water and with water with a chlorine residual maintained over a period of several days. The extraction was conducted by Anresco Lab (Attachment O) and the organotin measurements were made by West Coast Analytical Laboratory (Attachment Q). In all of the several pipe samples, tri-alkyl forms were found, whereas none were found in the blanks not exposed to CPVC pipe material. (See Attachment Q Report "A" pages 3 & 4 and Report "C" pages 3 & 4.)

There are very few laboratory studies of organotin leaching from vinyl pipe material. It is not easy to determine whether the studies actually looked for tri-alkyl as opposed to mono or dialkyl forms. For example Forsyth and Jay may not have been able to detect trialkyl tins. The only study stating that trialkyl tin compounds were studied was Boettner, 1982.

We do not know the actual magnitude of contamination, because there has been no systematic

attempt to determine actual tri-alkyl tin presence in CPVC resin. Because it appears as a contaminant we would expect the presence of tri-alkyl tin contaminants to be highly variable. Ideally, we could look to NSF to see whether tri-alkyl tin contamination had been noted in the past, but unfortunately NSF conducts no organotin measurements and its tests of inorganic tin are naturally incapable of determining the nature of organotin compounds present in pipe leachates. The project description should discuss the potential of tri-alkyl tin contamination and present laboratory analysis of tri-alkyl tin presence in CPVC resin.

Residual Monomer

CPVC is made from PVC, a polymer of vinyl chloride. Because vinyl chloride monomer (VCM) is a known carcinogen and because earlier manufacturing of PVC and CPVC resin tests allowed substantial VCM residual in the finished product, NSF adopted a VCM leaching test as part of its standard protocol. Interestingly, residual vinyl chloride is still detected in the public water supply from pipes installed over a decade or more ago. This illustrates the capacity for vinyl plastic to leach substances over a very longtime. According to a US EPA letter regarding vinyl chloride contamination in the Kansas public water supply: "KDHE [Kansas Department of Health and Environment] believes they have collected enough samples from different areas of the distribution system to conclude that the vinyl chloride appears to be leaching from the oldest 70-80% of the distribution system, that is, the pipe that was installed in the late 60's and early 70's." (see Attachment D: Elizabeth Murtagh Yaw, USEPA, April 1, 1993 letter to Mr. Dave Eckstein, Uni-Bell PVC Pipe Association)

Butadiene, the monomer used to make butadiene rubber, is also a carcinogen. If butadiene rubber or other polymers are now used in "CPVC" pipe resin, does NSF test for these contaminants? Are there are formulations which may use styrene or acrylonitrile? If these or similar compounds may be used in the future, how can the state be assured that there will not be a leaching problem?

Post-Chlorination Products

Unlike most plastics, the polymer chain in CPVC is not made by the assembly of individual monomer sub units. The process whereby PVC is converted to CPVC entails aggressive chlorination of the PVC polymer. The post-chlorination replaces most of the hydrogen atoms on the PVC polymer chain with chlorine atoms. Other molecules present in the PVC resin starting material will also be subject to chlorination, and the conditions of post-chlorination may also degrade the PVC to some degree creating smaller, potentially mobile molecular fragments.

The issue of dioxin production from incineration of PVC waste has been raised by environmental groups in North America and in Europe. In particular the organization, Greenpeace has made dioxin pollution a focus of activity. The post-chlorination of PVC raises the possibility that dioxin and related chlorinated compounds may be created in the CPVC resin. One occupational health study in Germany detected dioxins in the air where CPVC resin was being extruded as plastic pipe (see Attachment A: Gesellschaft fur Arbeitsplatz- und Umweltanalytik, "*Orientational air studies for PCDF/D during extrusion of C-PVC.*" Nov. 22, 1991) Despite the sensitivity of the dioxin pollution issue, industry has published no follow-up. Rather, industry cited the particular CPVC extruder as an unusual case and asserted, without proof, that dioxin

was not a relevant contaminant of CPVC.

A sample of CPVC pipe was subjected to dioxin testing for Thomas Reid Associates. The sample was obtained in San Francisco by Anresco Lab (Attachment O) and analyzed by Quanterra (Attachment P). This single analysis found octochlorodibenzofuran, one of the dioxin family of toxic substances. While no estimate was made of the capacity to leach dioxins from CPVC pipe, the extreme toxicity of dioxins and the logical pathway for their formation post-chlorination shows the need for the EIR to seriously investigate the potential for contamination.

The dioxin contamination issue is known to B.F.Goodrich and should have been communicated to HCD. HCD could also have discovered the issue by examining sources beyond B.F.Goodrich. The issue is relevant to the problem of multiple CPVC manufacturers using different processes with potentially different capacity to produce post-chlorination contaminants. It is also relevant to HCD's reliance on NSF to define the potential for public health impacts because NSF does not test CPVC pipe or CPVC pipe leachates for dioxins.

Heavy Metals

Other than tin added in organic form as a stabilizer, heavy metals are not a named ingredient in CPVC resin. In the aqueous extraction test conducted in 1998 for Thomas Reid Associates, lead was detected at significant levels in the extractant, but not in the blank. (Attachment Q, page 9-A). The method used to extract the pipe cleaned the outside to prevent external contamination and we conclude that some extractable form of lead must be present in the pipe. Perhaps this is an unidentified ingredient or a contaminant in the stabilizer. Has HCD reviewed any extraction test, such as those conducted by NSF, to determine if lead or other heavy metals other than tin are found? If so, what is the source of these substances? Does NSF ever fail any CPVC or PVC products for lead?

E. Incorrect Characterization of Solvent Cement.

The EIR places great emphasis on the putative change in solvent cement formulation in response to California air pollution regulations limiting VOC content. The EIR authors would have realized that this reliance is unfounded if they had investigated the nature of the VOC limitation and the history of so-called industry compliance.

The EIR reasoning is summed up by the statement, "The composition of the solvent cements and primers has been changed. The technology of solvent cements has advanced significantly in the past several years, and has reduced the concentration of volatile organic compounds (VOCs). This has been in response to the regulation of solvent cements and primers for the solvent welding of plastics by the California Air Resources Board (CARB) and Regional Air Quality Maintenance Districts (AQMDs). This reduction in VOC content of cements and primers applies to many adhesives and sealants, not simply those formulated and sold for use with CPVC pipe." (P. 45)

Currently available "Low VOC" Cements are no different than previous products tested

In fact, the technology of solvent cements has not advanced. The technology in use today and in

the foreseeable future in California is the same as was used 20 years ago. To make a strong joint, the cement must partially dissolve both the pipe and the fitting so that the surfaces can be forcibly joined and "welded" together. Solvent cements permitted by code comprise plastic resin dissolved in a mixture organic solvents. The solvents are selected to provide and effective "bite" on the hard pipe surface over a wide range of ambient temperatures. The solvents are generally oxygen containing: ketones such as MEK, acetone, and cyclohexanone, or the cyclic ether, tetrahydrofuran. Formerly, dimethyl formamid (DMF) was used but due to toxicity concerns in the late 1980s, it was prohibited from solvent cements. The dissolved resin is meant to provide proper consistency for application and to fill voids at the edge of the joint, but it is clearly the solvent action on the pipe surface that provides the strength.

The EIR omits three key points of information. First, solvent cement and primer have always varied widely in the proportion of the various solvents used. The variation may be due to different manufacturer preferences in formulation and may be due to changing cost of materials. Second, the VOC limitations in effect have been adjusted upwards to allow industry to meet the limitations with existing products. Each of the major air quality management districts has set a timetable for VOC reduction that has been repeatedly delayed because industry cannot in fact make an acceptable product that meets the lower limits. Third, the ability of existing cement formulations to comply with the VOC restrictions is achieved because the California air districts have been adopting regulations which exempt acetone as a VOC.

The acetone exemption stems from EPA regulation 40 CFR 51.100 which finds acetone "negligibly photochemically reactive" and CARB Draft Proposed Determination Of Reasonably Available Control Technology And Best Available Retrofit Control Technology for Adhesives and Sealants (April 1998). This has been incorporated in some air district rules, e.g. South Coast Air Quality Management District rule 1168.

Thus, the so-called low VOC products are not appreciably different from ordinary solvent containing products. The "low VOC" is achieved by using a test method which still leaves solvent in the joint, and by using exempt acetone as needed to meet the limitation. Acetone has always been a component of these solvent products; the only "new technology" is adjusting the acetone content to meet air district rules.

When the EIR speaks of "technology-forcing requirements of CARB" (P. 50) it may be unaware of the history of the low VOC regulations and the fact that the initial two-step standard process envisioned to force the technology has stalled. For example, in the South Coast Air Quality Management District, initially, cements were to comply with a 450 gram/liter limit with a lower limit of 250 g/L to be attained in 1993. What has happened is that the initial limit was raised to 490 g/L to allow existing cements (with acetone added) to comply, the second step was raised to 270 g/L and the attainment for that lower limit has been repeatedly delayed from 1993 to 1998, and to 2003. Is HCD relying on the lower "technology-forcing" VOC limits in making its determination? If so, those products are not available and are not likely to be available for some time.

The matter of low VOC adhesives is important to the EIR, and the EIR should address the issue quantitatively. First, the EIR should list the primers and cements available in California, list their constituents, and show whether or not they comply with the VOC limitations. A list of

ingredients from various sources is attached (See Attachment I). It shows substantial variation and implies that several of the products are unlikely to actually meet the more strict VOC limitations in the Bay Area and in the South Coast air districts. The comparison of cement and primer lists composition from the 1980s era of the leaching and worker exposure studies and from so-called low VOC products today. The range of variation is indistinguishable. In the 1980s, some products were all acetone or all MEK, cements used a large component of THF. The same is true today. Obviously, technology hasn't been forced yet.

Note that several "low VOC" primers are mostly non-exempt solvent and could not meet the 650 g/L air regulations. IS HCD relying on actual use of a low VOC product? Does HCD know whether compliance is verified?

Second, the EIR should evaluate how primers and cements will meet the stricter VOC limitations scheduled by California's major air districts. In addition to acetone, the air districts exempt certain chlorinated solvents from VOC roles. If industry was required to meet scheduled lower VOC limits, what additional exempt solvents may be added? Is HCD referring to existing "low VOC" formulations or is it anticipating some future alternative formulation? "...the Lead Agency finds that the potential significant effect of contributing to air quality degradation due to emissions of VOCs, will be less than significant if CPVC is approved for residential use. In summary, this is due to the changes in the technology of CPVC joining brought about by the technology-forcing requirements of the CARB." (P. 50)

Without this level of analysis, without any quantitative assessment of the chemicals involved, the EIR has no basis to make statements such as, "The Lead Agency will require, as part of the proposed Regulations, the use of low-VOC cements and primers statewide if it determines to approve the use of CPVC for potable water piping in residential buildings in California. This will greatly reduce the potential for worker exposure to solvents, compared to the situations which were previously studied by the Department of Health Services." (P. 48)

" This proposed measure is not, strictly speaking, a mitigation measure under CEQA, since the effects addressed are not significant adverse impacts." (P. 48) "(At the time this health risk assessment was conducted low-VOC cements had not been developed)" (P. 36)

One-step Cements are not Approved

The code subject to approval as the lead agency's proposed action requires the use of a primer before application of the solvent cement. This so-called two-step process increases the VOC emissions and increases the occupational exposure to solvents. Although the EIR stops short of acknowledging that the emissions from the primer-cement assembly affect either air quality or worker health, the authors wistfully cite the availability of a "one-step" cement to further reduce impact.

The EIR logic is, "In addition to the low-VOC materials now available, another of these technological advances is the development of solvent cements which do not require the use of primers (one-step cements). Neither of these advances in technology involves the use of solvents not used in the previous products. " (P. 46)

The one-step cement is not approved for CPVC use. The CPVC resin is denser and harder than PVC, the surface of the CPVC may also have a coating of lubricant or stabilizer left from the extrusion process which would interfere with solvent attack on the pipe surface. Pipe assembly instructions caution that the use of a primer or cleaner is necessary to remove grease or oil. The requirement for use of primer is made clear in the UPC Section 316.1.5: **"316.1.5 Solvent Cement Plastic Pipe Joints.** Plastic pipe and fittings designed to be joined by solvent cementing shall comply with appropriate IAPMO installation standards.... CPVC and PVC pipe and fittings shall be cleaned and joined with listed primer(s) and solvent cements."

HCD's proposed adoption of the UPC says not only that primer must be used (UPC Section 316.1.5), but makes clear that the primer must be colored differently from the cement (UPC Section 301.1.2.4.2). The color requirement here is different from the worker safety prohibition against clear, uncolored primer. The reason for the code contrasting color requirement is to allow a building inspector to inspect a joint and assure that a primer was in fact used, as required by code.

The rejection of the one-step cements now on the market is based on the difficulty of the cement adequately wetting and softening the pipe surface. Although the tone of the discussion in the EIR that these technical problems could be overcome politically, there will probably need to be further technical development before one step cements are available. A successful one-step cement may involve the addition of different, more aggressive solvents. What does HCD find is different about the composition of one-step cements now being tested and the current approved cements? None of the information submitted by B.F. Goodrich to HCD on the suitability of one-step cements ever mentions their solvent composition. Because one step cements are not approved, HCD has no basis to conclude that an approved one step cement will not use different solvents than are now found in the two-step, primer/cement process.

F. Failure to identify reasonably foreseeable actions which contribute to cumulative impacts.

The HCD EIR describes existing uses of CPVC pipe and related PVC pipe, but only to show that the propose approval for residential potable water use is not a radical change. HCD should acknowledge that potential for cumulative impacts such as from exposure to organotin leaching from vinyl piping. The recent work by Sadiki on public water supply shows small, but variable amounts of organotins from areas where PVC has been used for public water supply. HCD should acknowledge that new homes will be built in new subdivisions where there may be a greater tendency to use PVC for water supply. The potential leaching from the residential plumbing will be added on top of the leaching from the public piping system. Because one of the unresolved health issues for organotins is immune response suppression, the real possibility of an individual being exposed to low but inescapable organotin exposure should be acknowledged.

In the area of worker exposure, the EIR should define the potential for cumulative exposure to solvents from DWV, sprinkler and potable water. Exposure from potable water will not be the only source and the tolerance of an increment may be less when the background is already high from other activities.

4. Unwarranted Reliance on NSF 61 to Protect Public Health

A. Introduction

Accurate and complete assessment of public health issues is essential for informed public review of this project. As discussed elsewhere in these comments, the EIR uses an abbreviated, non-quantitative project description and relies on incomplete and often irrelevant older leaching studies. At various points in the EIR, the authors seem to realize the limitations of their analysis and turn to NSF International as a catchall security for all health risks -- both present and future.

There are three fatal problems with the EIR reliance on NSF: 1) the lead agency has not independently reviewed NSF's work; 2) the lead agency does not disclose the limitations of NSF's testing; and 3) the lead agency does not acknowledge NSF's stern warnings that no governmental entity shall rely on its standards. Indeed, the EIR authors seem to confuse NSF, a private non-governmental organization, with the regulatory authority of the U.S. EPA or the state of California.

In order to demonstrate these problems, we first define the NSF process, focusing on NSF 61 the standard which specifically addresses plumbing materials in contact with potable water. This discussion begins with NSF's disclaimer, gives the history of the creation and adoption of NSF 61 and relationship to NSF 14, ASTM standards, and the Uniform Plumbing Code (UPC), and includes the delegation from NSF to the plastics industry of the maintenance of plastic pipe formulation. This is followed by an analysis of the extent and limitations of NSF 61 with respect to the health issues such as organotins that the EIR attempts to address. This section closes with an appraisal of the EIR's treatment of NSF and its apparent reliance on NSF as mitigation for the proposed project.

B. NSF disclaimer of responsibility

How can the Lead Agency rely on NSF 61 to protect public health when NSF 61 contains strong disclaimers of responsibility, "NSF shall not be responsible to anyone for the use of or reliance on this standard by anyone." (NSF 61, p. v), and advising, "Final acceptance of a product for drinking water application is the responsibility of the appropriate federal, state, or local regulatory agent." (NSF 61, Footnote 1, p. 1). This creates a circular connection between regulations because the DEIR states that if CPVC is allowed in California that it must be an NSF listed product, but NSF 61 states that acceptance of the product is ultimately the responsibility of the state. In order for "final acceptance" to be the responsibility of the state, the state must have upon hand and available to the public all of the information on which that acceptance is based.

C. Summary of NSF testing and certification process

Because the Lead Agency relies on NSF and NSF Standard 61 for HCD's determination of significance, a brief description of the organization, standard and certification process is given below.

NSF 14, Plastics Piping System Components and Related Materials, which was first adopted in 1965, establishes minimum physical, performance, health effects, quality assurance, marking and record keeping requirements for plastic piping components and related materials. It includes requirements for plastic pipes to be used for potable water but it also addresses non-potable water uses of plastic pipe. Section 7 of NSF 14 addresses the requirements for potable water plastic piping system components. Any plastic piping product intended for potable water uses must conform with both NSF 14 and NSF 61. NSF 14 also requires that plastic piping conform with a recognized performance standard, which in the case of CPVC for hot and cold water distribution is ASTM D2846 (NSF 14). The UPC, requires that CPVC pipes for water service meet NSF 14 (UPC).

NSF 61 replaced the EPA Additives Advisory Program for drinking water system components. The first version of NSF 61 was adopted June 1988 by the NSF Board of Directors. It was prepared by the NSF Joint Committee on Drinking Water Additives and the NSF Council of Public Health Consultants (both of whose memberships are listed in Appendix H of NSF 61). NSF 61 was approved by ANSI in 1989 and is now referred to as ANSI/NSF 61 (NSF 61).

Tests Required for Certification

For certification of plumbing materials in contact with potable water, NSF conducts leaching or extraction tests. Thirty randomly selected samples of the product must undergo extraction testing. Exposure testing is required of pipe products based on the intended end-use, e.g. hot or cold water, the test requirements are based on the material specific analytes . A contaminant will require toxicity testing if it is an unregulated contaminant, e.g. not listed in the NSF 61 Appendix under the EPA National Primary Drinking Water Standards or Canadian Maximum Acceptable Concentrations Primary Drinking Water Standards. (NSF 61 Section 3 & 4)

NSF 61 requires the manufacturer to identify possible formulation-dependent analytes. Table 3.1 in NSF 61 lists the material specific analytes for each material type such as metal, concrete, plastic, elastomer and other materials. CPVC material specific analytes are: regulated metals, phenolics, tin, antimony, volatile organic chemicals and residual vinyl chlorine monomer (RVCM). The analysis of tin or antimony is only required if that metal is used in the stabilizer. The applicant must provide formulation information and method of manufacture and a list of known or suspected impurities/contaminants and their concentrations. Substances selected for testing should include the product as formulated, product constituents, total extractants and any chemicals contributed to water as a result of product use. A modification in the selection of substances for toxicity testing is allowed if it is well-supported by documented scientific judgement and rationale (NSF 61 Section 3).

Toxicity testing requirements for an additive are based on the anticipated human exposure to the additive and is calculated using estimates of the concentration(s) of the test substance at the tap. This normalization process is outlined in NSF 61 Appendix B Section 12.

Toxicity testing requirements are described for each of the following four ranges of normalized contaminant level: Level I (<10 ppb), Level II (≥10 and <50 ppb), Level III (≥ 50 and <1000 ppb), Level IV (≥1000 ppb). With each level more types of toxicity tests are required. The toxicity testing requirements are cumulative, so that a Level III exposure will also require all tests

required in Levels I and II. A modification to the types of toxicity testing is allowed if well-supported by documented scientific judgement and rationale (NSF 61 Appendix A).

NSF Delegation to the Plastic Pipe Institute and Acceptance of the Range Formula

Apparently the certification of CPVC and PVC has been streamlined by increasing NSF reliance on an industry association, the Plastic Pipe Institute, a division of the Society of the Plastics Industry. This streamlined certification relationship is described in Otto S. Kauder, *Nontoxic Polyvinyl Chloride Processing Stabilizers*, Chapter 18 in Jesse Edenbaum, ed. Plastics Additives and Modifiers Handbook, Chapman & Hall, New York. 1996 P. 307. We include the discussion in full because the EIR itself does not disclose how NSF operates.

> "As part of the public water supply, pipe for potable water is under the aegis of the U.S. Environmental Protection Agency, which, however, has delegated to the NSF of Ann Arbor, Mich. (a private nonprofit organization), the authority to set standards and administer a seal of approval for products that meet these standards. The standards relate to the physical strength, integrity, and durability of the pipe and to the purity of the water delivered. The NSF, in turn, has delegated the authority over the physical characteristics of plastic pipe to the Plastic Pipe Institute (PPI), a division of the Society of the Plastics Industry. For many years, the NSF and PPI regulated the field of plastic pipe and its ingredients strictly by accepting each manufacturer's product--that is, each ingredient of a pipe "compound" and then the finished pipe made with these ingredients--upon submission of detailed information and samples and testing for compliance with standards for taste and odor, chemical migration, and physical properties. Thus multiple sources of supply of an ingredient, such as a resin, a stabilizer, or a pigment, required multiple acceptance procedures by the NSF and PPI.
>
> "As experience with the successful use of PVC stabilized with organotin and antimony mercaptide stabilizers accumulated, the NSF/PPI regulatory system was simplified in stages. First, the PPI agreed to permit conditional substitution of an "apparently chemically identical" ingredient for a fully accepted ingredient having passed 10,000 hours of hydrostatic testing at the point when testing of pipe containing an "apparently chemically identical" substitute ingredient passed 2000 hours. More recently, the NSF and PPI agreed to accept without further testing pipe compounds and finished pipe manufactured from a "range" formula owned by the PPI and accepted by the NSF. The range formula is, in effect, a generic recipe made with ingredients (resins, stabilizers, lubricants, pigments, etc.) taken from a list of ingredients previously accepted by the NSF and used in concentrations within the accepted range. One such range formula is as follows:

Ingredient	PHR *
PVC resin	100
Stabilizer	0.3 - 1.0
Calcium stearate	0.4 - 1.5
Paraffin wax	0.6 - 1.5
Polyethylene wax	0 - 0.3
Titanium dioxide	1.0 - 3.0
Calcium carbonate	0 - 5..0

Ingredient	PHR *
Process aid	0 - 2.0
Carbon black	0 - 0.2

* PHR is Parts per Hundred Resin, because the ingredients are added to the base of 100 weight units of resin, the total is somewhat greater than 100, thus PHR is similar to, but not the same as percent by weight.

HCD should determine whether such a "range formula" approach is being taken for all CPVC products likely to be certified by NSF and hence approved for use in California.

Calculation of Maximum Allowable Levels (MALs) for contaminants

For regulated contaminants the Maximum Allowable Level (MAL) shall not exceed ten percent of the EPA Maximum Contaminant Level (MCL) as cited in Appendix E of NSF 61 (NSF 61 Appendix A).

For unregulated contaminants, the MAL for a contaminant shall not exceed ten percent of the Maximum Drinking Water Level (MDWL). The MDWL is calculated depending on whether the contaminant is a carcinogen or noncarcinogen. A contaminant is considered a carcinogen if it meets EPA criteria as group A, B_1 , or B_2 (NSF 61 Appendix A).

The MDWL for a noncarcinogen contaminant is determined by taking the Highest No-Observable Adverse Effect Level (NOAEL) and applying safety factors and dosage/average intake conversions. For carcinogenic contaminants, the MDWL is calculated from a slope factor for human intake and the desired level of acceptable risk (NSF 61 Appendix A).

Certification Criteria Includes Approval Even If MAL Is Exceeded

The decision whether to certify a product that has unregulated contaminants at Level II or greater concentrations includes an option to certify the pipe product even if the exposure concentration is greater than the MAL (NSF 61 Appendix A, Fig. A2, A3, A4). What are the factors that allow approval of a product if the MAL is exceeded? NSF should disclose to the Lead Agency and the public if there have been any cases where a product has been approved even if a MAL has been exceeded and, if so, what was the justification for approval.

One way that NSF will certify a product which exceeds the MAL is by a time extrapolation where extractant levels are compared and NSF projects a complying end point. Has NSF conducted lab tests that would verify the long-term decay of extractant concentrations over time? If the procedures of NSF 61 have been ongoing for more than a decade, NSF should have information about long-term leaching.

Product Certification and Ongoing NSF Product Testing

After a product has been tested according to the protocols outlined in NSF 61, the "normalized" contaminant concentration is compared to the MAL established for the particular contaminants.

If the results are acceptable, NSF and the manufacturer enter into an contractual agreement and the product is certified and listed by NSF (NSF Web site, Drinking Water Additives, The NSF Certification Process).

The same need for disclosure also applies to ongoing NSF product testing. If the state is to rely on NSF, or other similar private company, the state should have an annual reporting of the actual performance of products subject to test: where high levels were measured, how many products failed, and what tests are being administered. This information will allow the state and the public of California to be informed and to be assured that public health is being adequately safeguarded.

D. NSF Confidentiality Requirement and Non-disclosure

Perhaps the most immediate obstacle to lead agency independent review of NSF is NSF's refusal/inability to disclose the data used to set standards and to determine compliance. The EIR needs to ask, what are the claims of the companies of why all of the above data must be kept confidential? The claim that the formula is a trade secret is not entirely valid because this information – at least in a semi-quantitative form -- is already available through patents, general industry knowledge and books. There is also a claim of ownership of the data. According to Ron Coiner, NSF in response to the question regarding why NSF was not able to supply the EPA with data that they had requested for the consideration of adding organotins to the Drinking Water Contaminant Candidate List:

> "...We have information that is confidential in nature. And in order for us to be able to provide that to EPA or to anyone, we have to get the permission of the people that own the data. NSF does not own the data. It's not ours to give out or distribute. And we are in the process of trying to get that authorization so that we can provide the requested information to EPA. (Ron Coiner Deposition, B.F.Goodrich vs. Village in the Lake in the Hills, March 24, 1998, p. 24-25)

Therefore, only NSF knows how a CPVC product is certified, not the public who use the products and must rely on a closed process to ensure that their health is being protected. Not even the EPA is allowed to see this data unless permission is granted by the companies. The EPA found this industry non-disclosure to be a significant barrier to EPA's ongoing work on drinking water contaminants. According to the EPA's announcement of the Drinking Water Contaminant Candidate List:

> "The Agency agrees with the NDWAC Working group recommendation that an assessment of the toxicological data underlying the action levels established by the NSF needs to be made along with assessment of other available information on organotins, before these compounds can be disregarded as of concern. The Agency requested this information from the NSF, and learned that due to confidentiality agreement, NSF cannot disclose this information, therefore we have not yet been able to assess the toxicological data." (Federal Register: March 2, 1998 (Volume 63, Number 40), p.10282)

Since the DEIR is relying on NSF 61 to protect public health, the Lead Agency and the public should have access to this data.

Non-Disclosure Limits the Public's Ability to Review the Draft EIR

Because the EIR does not present factual information on NSF standard setting and product testing, the public has no opportunity for meaningful comment on the appropriateness of NSF 61 to protect public health from potential leaching from CPVC pipe. None of the data listed above is provided in the DEIR nor is it available to the public from NSF. The only thing available for the public to review is the NSF 61 standard and referenced EPA risk assessment, which is only the methodology. One cannot ascertain whether the MALs set by following NSF 61 Appendix A are based on appropriate toxicological studies because these studies are confidential.

There are other problems with NSF 61 and the NSF certification and testing process that have not been be addressed by DEIR.

MALs for unregulated contaminants

Until recently, the MALs developed for unregulated contaminants were considered confidential since the companies paid for the toxicity tests to establish these MALs and NSF did not own the data. Unregulated contaminants of concern include organotins, THF, MEK, cyclohexanone, acetone. This year, NSF has disclosed the MALs for organotins only due to the consideration of organotins in the EPA Contaminant Candidate List process. Only now have the MALs been disclosed for THF, MEK, cyclohexanone and acetone and this only as a result of this DEIR process. Ron Coiner, Manager of the Plastics, Plumbing and Mechanical Programs at NSF International, when asked whether the action levels for unregulated contaminants are considered confidential stated:

> "...some of the information that may be used in developing those acceptance criteria can be of a confidential nature. And currently, we do not publish the acceptance criteria for the unregulated contaminants in standard 61. So that the end result is that they're typically handled by staff internally here at NSF as confidential." (Ron Coiner Deposition, BF Goodrich vs. Village in the Lake in the Hills, March 24, 1998, p. 74, Attachment K)

In addition to material-specific analytes, NSF toxicologists may require additional testing of substances based on formulation information provided by companies. NSF relies on the companies' formulation information being accurate instead of running a broad scan for all possible substances. There are three main ways to determine pipe ingredients: require companies to provide formulation information and possible impurities/contaminants and their concentrations, an unannounced inspection of manufacturing plant and sampling the resin that is being produced to see whether it agrees with formulation information, and run a broad scan for all possible substances (a GC/MS scan is an example of a broad scan). NSF 61 requires the first two for CPVC products, but not the last. According to Table 3.1 Material Specific Analytes, a GC/MS is required of some materials such as PEX, Isoprene and Portland Cement, but not of other materials like PVC and CPVC. The problem is that some contaminants or impurities may be missed if a broad scan is not performed.

The formulation information is may be insufficient to determine potential contaminants. Based on the standard formula process described above, NSF may not actually have access to real formulation data. The formula may be provided in general, categorical terms without

information about the specific constituents. Without that information, NSF may not have knowledge of product specific contaminants such as tri-alkyl tins and residual monomer.

Application of more rigorous testing is not impractical, and apparently is conducted by other health standard organizations. The United Kingdom (UK) has standards that require a broad scan of possible contaminants. In the UK, testing and approval of potable water products are divided into two sections: products designed for use in buildings (domestic, commercial, industrial) and products designed for use in water collection, treatment and distribution (the public side).

The UK testing requirements for CPVC pipes for potable water are contained in BS 6920, "Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water." For the public side, the actual testing requirements are based upon product formulation and a GC-MS general scan for unsuspected organic leachates, together with specific analysis for any ingredients or manufacturing by-products which may have a toxicological impact. (BS 6920)

E. The "Normalization" Process

NSF laboratory testing measures the concentrations of contaminants in extractant water. NSF applies a "normalization" factor to determine "at-the-tap" exposures which is multiplied times the laboratory result before comparison with maximum allowable levels of the contaminant. The normalization factor is always less than one and thus reduces the amount of contaminant reported and makes it easier for the pipe to pass the MAL. The normalization factor is essentially a "fudge factor" and apparently adoption of the normalization factor makes it easier for products to pass NSF extraction testing (see discussion of lead-based stabilizers, above).

NSF's procedure is found in NSF 61, Appendix B Section 12. The concept behind normalization is logical: laboratory tests have a greater surface to volume ratio and a greater dwell time for extraction then would be found under customary usage in actual applications. The normalization method developed by NSF is fairly complex and is based on a series of assumptions of the extraction environment of actual installations in contact with potable water. Much of the development of normalization factors pertains to public water supply piping and storage tanks where clearly the very large volume of water and relatively rapid flow rate would produce lower effective leaching than would be measured in the laboratory.

For residential installations, the assumptions behind the normalization factors may not be sufficiently conservative. The section of Table B.15 addressing residential pipes is based on 280 feet of ½ inch nominal [inside] diameter pipe with a static volume of 2.86 gallons, and a residential water usage of 180 gallons per day, with a 16 hour active flow rate of 120 gallons. NSF calculates a 0.76 multiplier normalization factor for static concentration and an additional 0.024 multiplier for flowing concentration, resulting in a combined a factor of 0.0182. In application, if NSF set a limit for long-term exposure of 20 ppm, NSF would pass a pipe sample that produced a laboratory extractant concentration of 1,000 ppm -- 54 times the limit.

NSF has also developed a normalization factor for residential fittings -- appliances, faucets and the like dispensing potable water. Because NSF assumes that fittings represent only six percent of the residential system total, the static volume of the fittings is only six percent and thus the

normalization factor for fittings is the residential pipe factor times an additional 0.06 multiplier. Again, in application, if NSF set a limit for long-term exposure of 20 ppm, NSF would pass a fitting sample that produced a laboratory extractant concentration of 18,000 ppm -- 914 times the actual limit.

The ongoing concerns for lead in drinking water is focusing on brass used for fittings. The EIR cites some of the current public health discussion of lead in its assessment of copper piping, without distinguishing the lead contribution from the fitting from any contribution from the pipe. Brass is limited to 8 percent lead content, but retains lead as an important component for ease of machining. The brass fittings are ANSI/NSF 61 certified and are presumably subjected to NSF extraction tests. With nearly a thousand-to-one fudge factor on test results, it is easy to see how high lead levels, and lead levels well in excess of Proposition 65, can be measured in the field from code-complying fixtures.

The same concern applies to plastic pipe in the residence. Depending on the pattern of actual use, much of the potable water ingested could have a higher dwell time then is accounted by NSF's assumption of 120 gallons flow in the day. A glass of water, filled coffee pot, reconstituted juice all take a fraction of a gallon and when drawn from the tap the water consumed may have a higher contaminant concentration then afforded by NSF's normalization factor.

F. No NSF 61 Direct Testing Method for Organotins

NSF does not conduct any tests for organotins – either of pipe resin or of water extractions. How can HCD conclude that NSF is a reliable source for testing of organotins? The way that NSF certifies plastic pipe for organotins is by an indirect measurement: NSF measures the inorganic form of tin and then correcting for the molecular weight to estimate the organotin species. NSF does not state how it actually converts inorganic tin extraction results to determine compliance with the MAL. Has HCD examined this calculation and found it appropriate? The problem with this method is that it cannot determine the actual amount of organotins or which organotin species is present. Thus NSF testing cannot be a basis for the EIR's assertion that no trialkyl tin species are present in plastic pipe.

As described in Section 3 of these comments, trialkyl tin was found in a laboratory test of CPVC pipe. The samples subjected to organotin analysis were also subjected to inorganic tin analysis. The field blank (plain water not exposed to CPVC pipe but handled and transported from San Francisco to the laboratory with the extract samples) had detectable inorganic tin, but no detectable organic tin (Attachment Q). For HCD to make use of NSF data, it needs to determine whether NSF subtracts the inorganic tin found in a blank from the inorganic tin in the extract when NSF calculates possible organic tin.

G. Relying on a third party for implementation of a standard

Normally when relying on third party for implementation of a standard there are assurances that the third party will take responsibility for the standard. Although the DEIR concludes that leaching is not a significant impact requiring no mitigation, it reaches this conclusion based on the reliance of NSF. Technically, reliance on NSF 61 is not a mitigation, however, it is necessary

to support the Lead Agency's assertion of nonsignificance. Normally when relying on third parties, such as a responsible agency, for regulations or standards there are assurances that the third party will take responsibility for the mitigation. For example when a project has an air quality impact, most air quality mitigation would be responsibility of the regional air quality district. There is assurance that this mitigation will be implemented because it is in the jurisdiction of another agency.

The Lead Agency's reliance on NSF 61 to ensure the protection of public health and therefore NSF International as the third party implementor is problematic. As noted above, NSF 61 contains strong disclaimers of responsibility, "NSF shall not be responsible to anyone for the use of or reliance on this standard by anyone." NSF 61, p. v, and advising, "Final acceptance of a product for drinking water application is the responsibility of the appropriate federal, state, or local regulatory agent." (NSF 61, Footnote 1, p. 1). Without a party willing to take responsibility that the standard will be implemented, and without open access to NSF's information, testing procedures and standard setting, the lead agency that must certify in the EIR that the project avoids significant impacts to the environment cannot exercise its independent judgement and has no factual basis to support its determination.

Delegation of public health protection to NSF, a non-governmental organization supported by private industry is problematical. How can a CEQA determination of non-significance be made based on implementation of standards by a non-governmental organization that cannot be held publicly accountable. EPA awarded the development of NSF 61 to a consortium led by NSF to develop voluntary third-party consensus standards. But what type of oversight is the EPA allowed in the implementation of NSF 61? NSF even keeps information from the EPA confidential, as was noted above in the case where the EPA requested information from NSF in conjunction with the Drinking Water Contaminant Candidate List process. As discussed above, the EPA requested the toxicological data that supported the action levels set for organotins, however NSF could not provide the information due to confidentiality agreements.

The NSF Task Force groups that look at the toxicological data on various contaminants are heavily represented by industry. For example, NSF organized a Tetrahydrofuran (THF) Task Group in response to the National Toxicology Program's study on THF. According to the minutes from the meeting, there was broad representation from the industry (including B.F.Goodrich, Oatey, etc.); only one representative from the EPA was present and there did not appear to be any representatives of consumers or workers. This task group was meeting to discuss whether the MAL set for THF should be changed based on the NTP's THF study. The conclusions were that the industry would perform further toxicological testing before any action was taken. (NSF Tetrahydrofuran Task Group, Meeting Minutes, July 10, 1997)

H. EIR use of NSF in lieu of real mitigation

The EIR relies on NSF 61 to address potential leaching impacts from CPVC pipe which is inappropriate given the inability of HCD to claim independent review of NSF 61 and when the critical information necessary for an independent judgement is confidential, and given the problems with the NSF 61 process.

The Lead Agency claims it independently reviewed NSF standards and found them to be

conservative and protective of public health. The DEIR states that:

"The Lead Agency considers it to be reasonable and prudent to apply the standards of safety and suitability for use relied upon in the regulation of public drinking water systems to the potable water systems of residential buildings. The National Sanitary Foundation (NSF) certification is generally considered to provide sufficient protection of public health from contaminants in drinking water arising from materials in contact with potable water." (p.17)

"The Lead Agency has also independently reviewed the NSF Standards for Drinking Water System Components Health Effects (NSF 61) <23> and finds them to provide a reasonable assurance of safety." (p.18) emphasis added

"The Lead Agency considers NSF testing and certification to established, human health conservative standards to provide a reasonable assurance of safety." (p.18)

"In the absence of MCLs, the Lead Agency has relied on the MAL determined by NSF using the formal risk-assessment methodology developed in the USEPA-sponsored program to assure safety of products which contact drinking water." (p.21)

"Under the proposed building standards, only CPVC pipe, fittings, and cements which are tested and certified by an independent entity, NSF, would be allowed to be used for potable water piping in residential buildings in California as is the case in other states and the model code. The Lead Agency considers NSF testing and certification to established standards of suitability for intended use (NSF 14) to provide a reasonable assurance that these materials are suitable for their intended use." (p.29-30)

The information relied upon by the Lead Agency [in it's determination that contamination of drinking water by leachates from CPVC does not result in a significant impact] includes the following:

....If the Lead Agency determines to approve the use of CPVC for potable water piping in residential buildings, only materials certified by NSF (NSF 61) will be allowed. NSF certification is now required for any material used in public drinking water treatment and distribution systems, and expanding this requirement to residential potable water piping will provide consistency of protection from the drinking water source to the customer's tap. As discussed in Chapter 3 of this EIR, NSF certification is relied upon by other public agencies in other situations pertaining to drinking water safety. Based on review of the NSF Standards and testing, the Lead Agency considers NSF testing and certification to existing standards to provide a reasonable and conservative presumption and assurance of safety. The standards which NSF tests against are based on a conservative human health risk assessment process." (p.37) emphasis added

I. HCD Lack of Independent Review

The EIR has not provided evidence that the Lead Agency "independently reviewed" NSF 61. In the following quote there is reference to a document that does not prove independent review of NSF 61:

"The Lead Agency has also independently reviewed the NSF Standards for Drinking Water System Components Health Effects (NSF 61) <23> and finds them to provide a reasonable assurance of safety." (p.18)

Footnote 23 is the Underwriters Laboratories 1997 document entitled: "*Drinking Water System Components, Component Materials, and Treatment Additives Directory.*" How does reference to this document offer proof that the Lead Agency "independently reviewed" NSF 61?

Further reference to the Lead Agency's review of NSF:

"Based on review of the NSF Standards and testing, the Lead Agency considers NSF testing and certification to existing standards to provide a reasonable and conservative presumption and assurance of safety. The standards which NSF tests against are based on a conservative human health risk assessment process" (p.37).

This reference does not provide any additional evidence of independent review. What exactly did the Lead Agency review to come to this conclusion? Did the Lead Agency only review NSF 61 and the related EPA risk assessment? What testing did the Lead Agency review?

The determination that leaching from CPVC products is not a significant impact cannot be made by HCD without reviewing the data that is considered confidential by NSF due to proprietary restrictions. The following lists some of the information that the Lead Agency would need to review to be able rely on NSF 61 protecting public health from potential leaching impacts from CPVC products.

1. A list of resin manufacturers.
2. The formulations used by each of these manufacturers.
3. For manufacturers using the range formula, what are the individual sources of additives such as stabilizers, lubricants, and pigments that are being used.
4. What outside, non-NSF approvals do those additives have.
5. What do extruders add to the pipe in addition into what is provided by the resin manufacturer.
6. For each CPVC product, what formula-based analytes did NSF determine needed to be tested.
7. What test criterion, meaning the MAL and the "at the tap" normalization factor is applied for any tests.
8. Testing history of CPVC products showing amount of analytes in the extractant or the percent of MAL. This would show the number of occasions when the MAL was exceeded and the general trend for variance in products.
9. For tests where the MAL was exceeded, what long-term extrapolation did NSF conduct to allow the product to be certified.

10. The underlying toxicity studies and data supporting the NSF standards.

Note that the EIR reliance on leaching studies conducted in the 1980s is a major deficiency. If HCD had attempted to access NSF's ongoing certification program, HCD could have substantially augmented its factual database.

Formulation information was not reviewed

The Lead Agency should have reviewed the formulation information submitted by companies wanting their product certified as complying with NSF 61. However, this information is considered confidential by NSF. Since this is a key to determining which substances are tested, the Lead Agency and the public does not know which substances are found in CPVC products and in what amounts. Since the types of tests required for a product are formulation dependent, the public will also not know what types of tests were required for a particular product.

Toxicity studies to establish MALs for unregulated contaminants are not reviewed

The toxicity studies that are used to establish the MALs for unregulated contaminants are considered confidential by NSF since they don't own the data. Therefore the Lead Agency and the public does not have access to this critical information. Full disclosure of the NSF procedure determining MAL is necessary for the state of California to place reliance on NSF. The MAL procedure entails NSF consideration of technical information from manufacturers and public health information. The public needs to see the range of information that NSF considers and how NSF uses that information. NSF's use of agency staff in its technical advisory committees is appropriate, but not a surrogate for public review and public involvement. If the MAL procedure is not public, neither the public nor the state of California will know whether information is complete and up-to-date.

The lack of review is reflected by the EIR's confusion in its reference to NSF's contamination level criteria. Where the EIR states, "In the absence of MCLs, the Lead Agency has relied on the MAL determined by NSF using the formal risk-assessment methodology developed in the USEPA-sponsored program to assure safety of products which contact drinking water." (p.21) it goes on to show two standards, one for short-term exposures (the STEL) and another for long-term exposures (the MDWL). The EIR does not actually discuss the relationship of these two standards to the MAL and the EIR does not establish whether these two standards or the MAL are intended as NSF test criteria or as drinking water criteria.

Attached to NSF 61 is Appendix E, Rationale Document for Additives Toxicology Review and Evaluation Procedures. Section 5.3, Unregulated Contaminants states that the "MAL for unregulated contaminants will not exceed 10 percent of MDWL". The EIR should clarify what standards HCD believes are being applied by NSF for organotins. What is HCD's assumption about the cumulative exposure to organotins and how does that effect the relevant choice of standard? In NSF's "Rationale .." It states that for carcinogens, the MDWL is calculated using 10^{-5} risk factor; HCD should examine how this relates to the state's statutory obligations under Proposition 65.

NSF explicitly warns all potential users of NSF certification that any reliance on NSF must only

be made based upon the independent judgment of the user. It may be convenient for the state to rely on the NSF process both for determining MAL's and for testing products in the marketplace, but that reliance cannot constitute blind delegation of the state's responsibility to independently determine that the public health has been adequately protected. If the state is to use NSF or any other similarly constituted private organization, the state needs to be able to show the public how the standards have been derived, how those standards relate to state law, and the state, at least, needs to be able to take public comment on those standards.

5. Ineffective Mitigation

One of the greatest deficiencies of EIR is its failure to objectively address mitigation. The potential mitigation measures have been the subject of discussion since the earliest days of EIR and throughout the legislative process which established interim use of CPVC. The EIR's refusal to aknowledge this past endeavor is baffling.

A. Denial of the Need for Mitigation

Perhaps EIR authors are concerned that acknowledging the possible benefit of, or need for, mitigation somehow would detract from the mandate to permit CPVC and the clarity of the policy statements in the document. This tone is set by the mitigation hesitatingly specified in the EIR: "C. Mitigation Measures Proposed to Minimize the Significant Effects:
This EIR finds that the proposed building standards will not result in any significant environmental effects. Therefore mitigation is not an issue. However, simply because the impacts are below the thresholds of significance does not mean that further reduction of impacts is not a desirable goal. The Lead Agency has incorporated measures (though not required as mitigation) to even further reduce the potential for impacts. These provisions in the proposed Regulations include:

- Requiring the flushing of all potable water systems in residential buildings, regardless of the material used. This will help to reduce the exposure of persons to leachates from pipe and joining materials such as fluxes and solvents, as well as dirt and debris which may contaminate the pipe and fittings.
- Allowing only the use of low-VOC primers and cements. This will provide for statewide application of standards developed by the ARB for application to regions with critical air quality problems. It will also reduce workplace levels of the same solvent vapors." (P. 104) Earlier, on page 50 the EIR includes one step cements in the general category of desirable changes, but omits them here.

This distinction begs the real question: what controls and conditions need to be in place to reduce adverse safety or environmental effects? Whether these controls and conditions come from industry or from HCD or from some third party, they need to be a part of the project future or else HCD's finding of no significant impact is without foundation. These comments demonstrate that significant impacts will result from product approval in the absence of mitigation. As discussed, the draft EIR's contrary conclusion is not supported by any facts or analysis.

Mitigation falls into the general categories of:

1. Product content (pipe and cements) as it affects potential for leaching into the water supply for the environment.
2. Product content (cements) as it effects worker safety.
3. Product content (cements) as it effects air quality.
4. Workplace installation: ventilation, gloves, etc.
5. Post-installation flushing.

The EIR only discusses controls over product content for either worker or consumer safety in the context of NSF. As described in the preceding section, HCD has not independently reviewed NSF and is unreasonably relying on NSF to mitigate product content risks. As part of the proposed project HCD should establish a formal monitoring requirement of NSF or of what ever

other entity provides testing and certification for products used in California. The full range of disclosure needed for the EIR is described previously.

B. Workplace Measures

Workplace installation controls are vital components of worker safety. In the previous, 1989 EIR, there is a substantial discussion of the need for ventilation, gloves, worker training and other factors to reduce solvent exposure. None of this is present in the 1998 draft EIR. A simple reference to product labeling is completely insufficient to show whether these measures are being applied and are effective when applied.

The EIR does not even acknowledge the results of efforts to mitigate CPVC impacts in a brief trial of CPVC in California. In 1995, the California legislature established a procedure for a two-year approval of CPVC. The approval incorporated some of the recommendations of the earlier CDHS into state law, Health and Safety Code Section 17921.9 "CPVC plastic piping; alternative material; safe work practices." The specific provisions for worker safety are:

> "(2) Cleaners shall be renamed as primers, include strong warnings on the hazards of using primers as cleaners, and include dyes to discourage use as cleaners. (3) Applicators and daubers shall be limited to small sizes. (4) Enclosed spaces shall be ventilated with portable fans when installing CPVC pipe. (5) Protective impermeable gloves shall be utilized when installing CPVC pipe." California Health and Safety Code Section 17921.9

As logical as these measure may sound, they may be impractical to implement and enforce. HCD should determine to what extent these measures were done during the period that law was in effect.

The EIR's complete silence on the issue of glove permeation considering that the issue was raised during scoping and the EIR's principal author observed a demonstration of solvent permeation of gloves conducted at the plumbers local Training Center in San Jose. During that demonstration gloves rated for use with solvents passed vapor from CPVC primer and cement through the glove in less than 20 minutes after exposure. The winter temperature at the Training Center was cool, permeation is more rapid in warmer weather.

The ERD prepared in 1983 for the state EIR lists gloves and permeation potential for different chemicals. There it is shown that THF is highly aggressive at permeating most glove material and that the material capable of resisting THF is attacked by other more common solvents and aqueous liquids. A series of glove permeation tests was conducted by TRI/Environmental using the only glove actually rated to resist THF (Attachment R). When exposed to PVC or CPVC solvent cement and primer, the resistant glove did not last the eight-hour test where THF was present.

The matter of glove permeation is serious, because the worker so exposed does not feel glue or liquid; only the vapor passes through, but passes through at high concentrations and continuously after exposure. This form of contact enhances skin absorption. The EIR can point to the requirement for gloves on the label on a can of solvent cement, but it must disclose to the EIR

reader whether that control will be effective. This is another indication of the EIR's lack of objective review.

The same problem holds for ventilation. There should be some standard that is easily observed in the field that will provide adequate ventilation under most reasonable conditions. It is not sufficient to observe a requirement for ventilation on the label on a can of solvent cement. The EIR should show what kind of ventilation is necessary to reduce solvent exposure to acceptable levels.

C. Flushing for Consumer Protection

The EIR does suggest that flushing after installation would be valuable for both metal and plastic. Is the flushing under discussion intended to be the same protocol described in the 1989 draft EIR? Or is intended to include only the code reference to section 609.9 disinfection of potable water system? In either case EIR should show how this short-term flushing would eliminate the longer-term leaching problems.

The EIR did not even address the minimal requirements once a part of California law. When CPVC pipe was allowed in Riverside and San Bernardino counties, the California state law, Health and Safety Code Section 17921.9 "CPVC plastic piping; alternative material; safe work practices." required that CPVC systems be flushed before occupancy:

> "(e) All of the following flushing procedures shall be adhered to when installing CPVC pipe in California after the effective date that adds this section [Oct 12 1995]: (1) When plumbing is completed and ready for pressure testing, each cold water and hot water tap shall be flushed starting with the fixture (basin, sink, tub, or shower) closest to the water meter and continuing with each successive fixture, moving toward the end of the system. Flushing shall be continued for at least one minute or longer until water appears clear at each fixture. This step may be omitted if a jurisdiction requires the building inspector to inspect each water system.
>
> "(2) The system shall be kept filled with water for at least one week and then flushed in accordance with the procedures set forth in paragraph (1). The system shall be kept filled with water and not drained.
>
> "(3) Before the premises are occupied, the hot water heater shall be turned on and the system shall be flushed once more. Commencing with the fixture closest to the hot water heater, the hot tap shall be turned be permitted to run until hot water is obtained. The time required to get hot water in a specific tap shall be determined and the cold water tap at the same location shall be turned on for the same period of time. This procedure shall be repeated in succession toward the end of the system." California Health and Safety Code Section 17921.9

Why are these not addressed? Is it because of EIR authors think that a discussion of flushing would lead to reader to believe the impact of solvent, organotin, or other leachates might be significant? Does HCD believe that these measures are unnecessary in California? Does HCD believe that these measures are a matter of ordinary practice and are routinely carried out

already?

D. Any Measures for Protection of Health, Safety and the Environment Need to Be Implemented and Monitored

Even if the EIR the wishes to avoid this stigma of required mitigation, it is extremely important for the EIR to sum up in one place what requirements will control the impact of CPVC plastic pipe and which of these requirements are specifically being proposed in the draft EIR to be placed on the approval by HCD. These requirements need to be stated clearly and quantitatively and there needs to be a relationship between the requirement and the environmental mitigation which would be accomplished. The EIR should state who would be responsible for implementing and monitoring the requirements.

The realm of mitigation should include public health, worker safety, and any feature of environmental impact where HCD has postulated some feature of CPVC which reduces or eliminates impact otherwise alleged.

HCD should assess how mitigating measures or any controls or requirements that limit the impact of CPVC would actually be carried out. The overarching need to monitor the product being used in California and to monitor NSF would fall to HCD. For some measures such as the use of gloves or ventilation, workplace inspection would be required. For other measures the local building inspector would be involved.

HCD should address the practicality of these measures. In the EIR, HCD vacillates on the subject of workers following label procedures or other requirements. Sometimes, HCD asserts that these good practices must be done whether they are done in fact in the field, and that HCD predicated its findings of no significance on an assumed compliance. And other times HCD acknowledges, or in the case of copper and lead-based solder, asserts that are not followed.

What counts are the impacts that will result from HCD's proposed action. HCD needs to list the labeling requirements or other regulations that must be followed and then identify potential barriers to their implementation. Without implementation these labeling requirements will not reduce worker safety, public health, or environmental impact.

6. Public Health

Plumbing for potable water is an essential public health issue. The primary focus has always been on the potential for chemical constituents of the CPVC plumbing system to leach into the water and to pose a health risk to the consumer. This section of comments begins with an overview of the technical studies referenced by the EIR which reveals a real paucity of information. The EIR discussion of leaching is so non-quantitative that it is difficult for the public to see the basis of the conclusions of no impact; the author assumes that a lack of information is a clean bill of health.

This section follows the discussion of leaching with the related issue of permeation. Finally fire safety while not a central theme with CPVC is also addressed as a public health matter.

A. Status of Technical Studies

Several areas of technical analysis are incomplete because there is not sufficient technical study of the underlying phenomena. The most significant lack is understanding of the long-term leaching behavior of CPVC pipe with respect to organotin and solvents, and the effects of chlorine residual in potable water.

The draft EIR is inconsistent in its presentation of technical studies. On the one hand, the EIR claims that there has been new information since the 1989 draft EIR, on the other hand the EIR relies entirely on the relatively scant information base which was available over a decade ago. Speaking of the 1989 EIR, the authors state,"much of the information is still the most current available and, therefore, the Lead Agency has used this earlier work." (P. ix) The authors then go on to claim, "The Lead Agency has not undertaken additional research since there is now adequate information available on which to base an informed decision regarding the potential for significant impacts from the proposed use of CPVC." Examination of the information referenced in the 1998 draft EIR shows that the state has done little to advance technical understanding of the issues since the work it has done previously.

Long-Term Leaching Behavior Undefined

The EIR claims, "There have been numerous studies and analysis of the effects of plumbing materials on water quality" (P. 68), but the document only cites two studies which bear on leaching from CPVC pipe in a simulated usage situation, with leaching observed over longer than a two-week period. The two studies are referred to as the Cooper study conducted for the Department of Housing and Community Development in 1987 by the University of California at Berkeley, Sanitary Engineering Laboratory, and the Butter study conducted for the Vinyl Institute by Foremost-McKesson in 1986. The Vinyl Institute work was largely directed by B.F.Goodrich.

All of the other citations offered by the draft EIR are not in fact technical leaching studies, but are secondary analyses and do not present information independent from either the Cooper or the Butter studies.

The EIR cites a study by CH2M-Hill "*Metal v. Plastic Pipe: A Comparative Health Risk Assessment on Drinking Water Quality.* 1987. Prepared by CH2MHILL for the Lead Agency)" (HCD-82, P. 65). If the authors had inspected the document they would've seen on the cover that the CH2M-Hill report was prepared for the Vinyl Institute and in the summary that it is based solely on the Foremost-McKesson work done earlier for the Vinyl Institute in 1986.

Other, earlier laboratory studies were only preliminary investigations into leaching. The J. M. Montgomery study in 1982; *Diffusion of Organics from CPVC Pipe*, J.M. Montgomery, Consulting Engineers, Inc., Pasadena, California, September, 1982., did, in fact find phthlate in the leachate, but this was later determined to be contamination from phthlate plasticizer in laboratory tubing used to connect the test cells. It is inexplicable that the authors of the EIR would have failed to observe that distinction if the document itself had been inspected. The J. M. Montgomery study raised the issue of CPVC contamination by chloroform and other chlorinated solvents used at that time in its manufacturer. By the time that the Cooper and Butter studies were conducted, B.F.Goodrich had altered its manufacturing method to substantially eliminate the need for

chlorinated solvents as "swelling agents". Thus the Cooper and Butter studies only show leaching potential from CPVC resin manufactured without swelling agents. The earlier J. M. Montgomery study must be used to show potential chloroform leaching levels from CPVC pipe made from an alternative manufacturing method. As mentioned in comments Section 3 and as illustrated by B.F. Goodrich patent 5,591,497 (Attachment B), alternative methods are still considered currently available.

It is important to note that one of the key public health and drinking water safety issues in the current, 1998 EIR is the leaching potential for organotin compounds deliberately introduced into the CPVC resin as additives. None of the leaching studies referenced in the 1998 draft EIR tested for organotin leaching from CPVC. Therefore there is absolutely zero technical information on organotin leaching presented in the draft EIR.

Even the studies cited have significant limitations (see analysis below). The primary technical focus of the Cooper and Butter studies was solvents leaching from solvent welded joints during the early stages of occupancy. The Cooper study led to HCD proposing pre-occupancy flushing as a mitigating measure for solvents in drinking water. Neither the Cooper nor Butter studies indicate the long-term leaching behavior of organotin compounds embedded in the CPVC pipe matrix.

The only studies which bear on organotin leaching are recent research efforts undertaken in Canada (Forsyth and Jay, HCD-136, and Sadiki, et al, "*Pilot Study on the Contamination of Drinking Water By Organotin Compounds from PVC Materials*," 1996). Even here, the draft EIR attempts to minimize the significance of the issue without seeing whether those studies are in fact adequate as a basis for California decision-making.

What is perhaps most startling is the authors' reliance on NSF testing programs without disclosing any of the results of NSF tests. Presumably NSF has in fact been conducting leaching tests as part of its certification quality control process. These tests would have been conducted in the intervening decade since Cooper and Butter. While there are technical limitations with NSF testing protocol (see analysis below), the EIR should have, at minimum, shown the full range of NSF leaching test results on the CPVC products which would be marketed and used in California once HCD's proposed approval is granted. Where is the data that already exists?

Implied Reliability of Other Regulatory Procedures

An objective assessment of available technical studies would have shown HCD that many of the important questions to be addressed in the EIR could not be answered with available information. The EIR dismisses this deficiency by repeated references to other putative regulatory processes where other presumably "informed" decision-makers allowed the use of CPVC pipe. Most notably, the EIR's constant citation of "all of the other 49 states" which use CPVC, does not describe what scientific, objective, public regulatory process was used in any of those 49 states to approve CPVC. If those other states had in fact conducted independent reviews of CPVC, HCD could examine the technical record so developed, and incorporate it into HCD's own technical analysis as required by California law. The EIR does observe, "... other than in California CPVC pipe ... has never been independently regulated, other than through the Uniform Plumbing Code." (P. 2) In that light, the EIR should remove statements that imply that use elsewhere is evidence of

CPVC acceptability in California.

The other significant area of implied reliability is the EIR's reference to the approval of CPVC for public water supply distribution in California. Unaware that CPVC is not actually used for public water supply in California, the EIR states, "The public water supply systems which connect to and deliver water to residential buildings are regulated by public health agencies and the State Public Utilities Commission. This system has, in the instance of CPVC, resulted in different standards and materials for these potable water piping applications, even though the public drinking water flows directly from one to the other. " (P. 16) "Both CPVC and PVC piping systems are assembled using primers and solvent cements. The same solvents are used in primers and cements for both materials. These solvent cements and primers are also approved for use in public drinking water systems in California. The approval process for these materials includes provisions to assure protection of human health, safety and the environment." (P. 98) It is significant that the first statement occurs immediately under the heading "Regulatory Background and Independent Testing" which shows that HCD is lumping regulatory approval by another agency and independent testing as equivalent in value to its analysis.

This is clearly wrong: only by disclosing factual information and HCD's own independent analysis can HCD fulfill the requirements of CEQA. Vague and unsubstantiated references to other approvals have no meaning. If HCD thinks other regulatory approvals are relevant, then the EIR should include the results of specific documented tests, studies, or other analyses which the other agencies used to assure protection of human health, safety and the environment.

Available Studies Identified Work Needed, but Undone

Looking back at the studies that are available, each one acknowledged its limitations and usually included recommendations for further work. The EIR relies on the body of available work without determining whether the preliminary results are either applicable or definitive for the analysis the EIR is required to do. It may be a common trait of researchers to recommend further research, but the researchers' own warning to the reader should not be ignored by HCD. The lead agency should evaluate the original studies and show where subsequent work was done to remedy the deficiencies.

The EIR authors rely on the CH2M-Hill report, possibly under the erroneous belief that the work was done for the state of California, rather than for the Vinyl Institute. The EIR cites part of the summary from CH2M-Hill, but does not make reference to some of the more important parts of the work.

CH2M-Hill includes a section assessing the limitations of the Butter (McKesson) study it reviews. On page VII-33, it notes that the metal and plastic studies were conducted using different water systems and with different water types. It noted that trihalomethane data were statistically discounted due to the study methodology and, by inference, the results do not bear on levels of trihalomethanes that are of public health significance. Note that Butter did not measure organotin.

As is evident, even the consultants to the Vinyl Institute were aware of the preliminary nature of leaching studies. The critique is important to one of the fundamental jobs that the EIR must

accomplish: objective and full disclosure. Throughout the EIR, the authors have extracted negative results from the few studies available and have concluded that these non-findings are sufficient evidence to conclude no potential for public health impact.

The limitations of the studies relied on in the 1989 EIR were described in detail in the comments submitted on that draft EIR. No final response has been made to those comments and HCD should explain why the limitations identified there are not still relevant. Limitations that were identified included:

Sanitary Engineering and Environmental Health Research Laboratory Study (Cooper, 1987)

a. Problems with Protocol and Implementation of Study
   (1) Impaired Limit of Detection
   (2) Not All Leachates Identified
   (3) Sample Mixup or Analysis Conducted Past Due Date
   (4) Sample and Column Contamination
   (5) Inadequate Analysis of Cements
   (6) Duplicates Left Out of Average Values
   (7) Reporting of Data Out of Linear Range
   (8) Inadequate Statistical Analysis
b. Chlorination Omitted from HCD Protocol
c. Cooper Test Not Representative
d. Selective Interpretation of Results

McKesson Environmental Services Study (Butter, 1986)

a. Inappropriate to Rely on Vinyl Institute Sponsored Study
b. Problems with Protocol
   (1) MES "Chlorinated" Water Not Reported
   (2) High Background Levels of Halogenated Organics Obscure Test Results
   (3) CPVC Test Run with Very Cold Water
c. Errors in Interpretation
d. MES Elevated Temperature Test Not Reported
e. MES Cement Analysis Not Reported

The criticisms of the failure to investigate the relationship of chlorinated potable water and leaching are particularly significant. The widespread use and subsequent failure of PB piping probably was due to unaccounted attack by chlorine residual. While CPVC may be less susceptible to attach, chlorine residual will promote tin leaching and may react to produce other leachates. In the lab testing done in 1998 for Thomas Reid Associates, the CPVC pipe had a continual chlorine demand not shared by the blank. What was the chlorine reacting with?

Need for Objective Comparison of Studies

In order to demonstrate an objective review of available studies, the EIR should present in table or matrix with a side-by-side comparison of the leaching studies. This comparison should identify:

- The study principal investigator,
- the study year,
- who commissioned the study,
- what pipe material was studied,
- was the pipe material itself subjected to independent analysis of its chemical constituents,
- was the pipe material approved for use with potable water,
- were solvent cemented joints included for plastic, or for metal, were soldered joints used and was no lead solder used,
- what kind of leaching conditions prevailed (chlorination, pH, temperature, flushing interval, dwell time),
- how long the study was conducted (duration of simulation),
- what chemical analytes were studied (solvents, inorganic metals, residual monomer, chlorinated organics, organotins), and
- what were the practical limits of detection under the study conditions.
- The comparison should list any limitations acknowledged in the study report itself and
- it should present the state's objective assessment of how representative the study is to answering the fundamental questions in the EIR: what is a reasonable, but health-protective projection of long-term, cumulative, non-voluntary exposure.

When the state undertakes this necessary exercise, it will clearly disclose to the public that the studies available are few, old (many did not evaluate current plumbing products such as no lead solder and impact modified CPVC), and short-term – none beyond 75 days. Tests of chlorinated potable water and tests for organotins are conspicuously missing.

B. Potable Water Leaching

Given the limitations of the database used for the EIR is hard to see how HCD could reach its conclusions. The general theme is that studies found that substances leach, the leaching declines over time, and so concentrations must go to insignificant levels even though the studies themselves were not conducted so is to show this.

The EIR cannot readily dismiss the long-term and cumulative exposure to solvents, organotins and possible chlorinated organics which may leach from the pipe.
@@@
The EIR's concern for lead in drinking water is well founded. Elimination of lead based solders followed a general social effort to eliminate lead as an environmental contaminant: leaded gasoline, lead-based paint pigment, lead in pottery glazed cookware, and lead pipes. The EIR acknowledges brass as a source of lead, but refuses to separate brass fixtures from a metal pipe distribution system. The typical statement, "It is a certainty that the low lead solders and brass foundry products still contribute some lead to tap water. (P. 33) shows this co-mingling of concepts. While there is evidence that brass foundry products contribute lead to tap water, the EIR should acknowledge that brass foundry products may legally contain up to 8 percent lead and have extensive surfaces in contact with tap water whereas lead solder may legally contain no more than 0.02 percent lead and the solder line in a joint is a far smaller contact area. Does the EIR have any basis for the preceding statement? Is there an estimate of the proportion of lead contributed by solder compared with the proportion contributed by a brass fitting?

This comment is not academic. What the EIR apparently fails to recognize is that residences plumbed with CPVC will be fitted with fixtures made of brass. By lumping lead from brass with the invented lead from solder, EIR significantly miss-states a public health problem.

C. Permeation

Another area where the EIR gives short shrift to the potential public health impacts is in the area of permeation. The EIR assumes that CPVC pipe is sufficiently dense that permeation of organic materials from the outside of the pipe to the inside the pipe will be insignificant. The assumption of reduced diffusion seems reasonable based on a consideration of the increased chlorine content resulting from post-chlorination of PVC resin. However the concern for permeation continues to increase as the extent of contaminated groundwater becomes more widely known. The concern extends to new threats such as MBTE oxygenate a used in gasoline. It is significant to note of that the public water supply conveyors consider contaminated ground to be a counter indication for use of PVC pipe. Refer to the discussion in Section 2 of these comments. Note that the PVC pipe used for water supply is much thicker wall than the small diameter CPVC pipe proposed for residential use and would be far more resistant to permeation..

As was pointed out in comments on the inadequate project description, the project under consideration will lead to installation of CPVC in soil from the meter to the structure and under the slab in common residential construction. EIR should include specific test data on CPVC that will reflect the potential for permeation and as important, the potential for shortened pipe system lifetime due to exposure of the plastic pipe to potentially aggressive organic compounds.

D. Fire

The EIR treatment of fire and fire safety belies a lack of research. The treatment offered is nothing more than speculation as to the actual dangers attendant to residential structure fires.

Toxic Smoke

The major cause of death in residential structure fires is due to the incapacitation of occupants which prevents their escape before the fire has reached them. Smoke, with its toxic gas constituents, travels from room to room, within walls, and through ventilating systems reaching victims far before the direct heat of the fire. Carbon monoxide, hydrogen cyanide, hydrogen chloride, and phosgene all contribute to rapid incapacitation of fire victims.

The EIR discusses the generation of toxic gases during combustion of CPVC, but omits any mention of phosgene. Chemically, phosgene is carbon monoxide with two chlorine atoms attached. It is more toxic than carbon monoxide and was used in World War I as a poison gas. The EIR correctly notes the absence of nitrogen in the CPVC formulation, hence predicting the absence of cyanide, but incorrectly concludes that only carbon monoxide is a toxic concern for smoke.

Some 20 years ago the issue of phosgene as a component of toxic smoke from PVC fires was investigated. Articles such as, Dyer, R. F., and V. H. Esch, 1976, Journal of the American Medical Association, Vol. 235, No. 4, pages 393-397, "Polyvinyl Chloride Toxicity In Fires.

Hydrogen Chloride Toxicity In Fire Fighters" found that " However a wide variety of other toxic gases such as phosgene (75445), benzene (71432), toluene (108883), xylene (1330207), naphthalene (91203), and vinyl-chloride (75014) are present." But concluded that " The toxic effects of these gases are small when compared to the toxicity of hydrogen-chloride. The synergistic effects of these gases is unknown. Similarly, Bjerre a 1984, "Health Hazard Assessment of Phosgene Formation in Gases of Combustion of Poly Vinyl Chloride Using a Simplified Method of Mathematical Modeling", Annals of Occupational Hygiene 28 (1). 1984. 49-60. Found that, "Under extreme conditions with respect to composition, temperature and cooling rate of the combustion gases, dangerous concentrations of phosgene may have been reached within a fraction of a minute." , but also concluded that the rate of phosgene formation for PVC combustion was slow without catalysis.

It is surprising that the issue has not been revisited for CPVC. In PVC there is essentially at least one hydrogen for every carbon and for every chlorine so that the thermodynamically favored reaction of chlorine with hydrogen with the formation of hydrogen chloride is going to dominate the less favored reaction of chlorine with carbon. In pipe-grade CPVC, the chlorine content is much greater and the ratio of hydrogen to chlorine is far less than the stoichiometric one-to-one of PVC. The EIR recognizes this, " This is due to the chemistry of CPVC, specifically the fact that the polymer contains such a high percentage of chlorine that there is little for atmospheric oxygen to react with in a fire." (P. 55) With oxygen from air, heat from neighboring burning material, and carbon from soot or char as a catalyst, phosgene formation may be more significant.

HCD should query industry as to whether it has conducted such tests of CPVC itself. Has HCD inspected laboratory tests or field studies of CPVC in a fire? Although CPVC is less flammable than PVC, CPVC may have an even greater potential for toxic smoke generation than PVC.

Fire Propagation

The statement of the fire safety problem in EIR is clear, "It has been suggested that this could result in a faster rate of fire spread, if CPVC pipe passing through a wall were to melt or slump due to a fire on one side of the wall and leave an opening.(P. 53) Unfortunately EIR never gets around to answering the question. Does HCD have laboratory tests of CPVC potable water pipe performance in fire rated walls?

The draft EIR addresses fire propagation with speculation. The statement, "the metals used for potable water pipe are excellent conductors of heat and can contribute to the spread of fires through barriers." (P. 91) is unsubstantiated. The circumstances in which copper with water in it would be exposed to heat of sufficient intensity that it would breach a fire rated wall by conduction of heat along the pipe would probably have long ago caused a CPVC pipe to melt away from the wall and breach the fire ratings by allowing heat and flames to pass through. Does HCD have a comparison between CPVC and copper during a fire test? The reference cited to Parker addresses DWV not potable water. Because DWV is normally empty it will heat faster and the vertical vents would probably transfer heat differently than smaller diameter horizontal potable water pipe. This line of reasoning is another example of EIR's double standard of proof for metal and plastic.

7. Economic and Social Effects

The EIR refers to HCD's "goals of providing Californians with safe, affordable, and decent housing." (P. 71) These goals are laudable and widely shared, but the EIR appears to be using affordability of housing built with plastic pipe as a contributing motivation for approval of the project. The EIR claims the virtue of affordability and consumer choice for plastic pipe in construction but does not present quantitative, objective analysis to show to what extent this may be true.

Throughout the document, the authors make it clear that they favor the use of CPVC pipe, generally considering it preferable to copper. The promotional tone of the EIR reflects this favoritism and the document cumulates in a casual and almost colloquial statement of overriding considerations. The EIR states; " Even if new information comes to light in the future which might indicate some minor impacts of CPVC, it is now thought that the environmental, economic, and social advantages of approving CPVC would very likely override any newly discovered adverse attributes of CPVC." (P. 111)

What do the EIR preparers consider to be "minor impacts of CPVC"? Are potential leaching, air quality impacts from solvent use, worker health and safety impacts considered minor? The EIR should identify what "minor" verses "substantial" impacts are. The reader can surely see the difficulty HCD had with sifting through data and quantifying effect, but the implication of HCD performing some sort of balancing between "impacts" and "advantages" requires more quantification. In the socioeconomics section, HCD should show exactly how much or how little the proposed CPVC code change would benefit housing.

A. No Significant Difference in Cost

HCD's EIR perpetuates the myth that CPVC plastic pipe is a boon to affordable housing. The origin of this myth may be simply B.F. Goodrich marketing promotion, or it may be the common perception that anything plastic must be cheaper than anything metal. Considering the resources available to the Department of Housing and Community Development, it is surprising that the EIR does not contain real data on cost developed by HCD.

Instead, the EIR relies on a report comparing CPVC and copper (Kennedy and Jenks, 1995, HCD-251) to conclude that CPVC would have a lower installed cost than copper (DEIR, p. 105). Kennedy and Jenks does not provide the basis for its cost estimates and it appears that HCD has not attempted to obtain the actual bases for this analysis or to conduct its own independent review.

Does HCD's conclusion reflect the additional costs associated with the installation of CPVC pipe apparently not included in Kennedy and Jenks. According to Dickens (Appendix B of comments submitted by the California Pipe Trades Council on the 1989 plastic pipe EIR, Nov. 13, 1989, see Attachment F), there are additional costs associated with plastic pipe that must be factored into any economic analysis comparing copper and CPVC pipe:

Labor will be required to flush the plastic pipe system as recommended in the DEIR. However, the Kennedy and Jenks analysis does not take this cost into account in its economic analysis. If

labor for only two trips to the project site for flushing is included, an additional cost per building of $192.00 will be added to the total cost of the plastic plumbing pipe system (Dickens, p. 6-7). This is a conservative estimate since labor costs have increased since this analysis was prepared in 1989.

The DEIR does not estimate the cost of the ventilation required when gluing CPVC pipes together. A survey of existing ventilation methods suggests that a system sufficient to satisfy the DEIR's recommendation would add as much as $100 to the cost of installing a plastic system. (Dickens, p. 9.)

In order to control fire in buildings plumbed with plastic systems, special fire-stopping mechanisms must be placed in fire walls where plastic pipe penetrates. Special inspections will be required while construction proceeds since the evidence of installation of such mechanisms will not be visible after construction is complete. These inspections will cost a minimum of $150 for each unit in a multi-story building (Dickens, p.9.). This amount also applies to single family units and probably has increased since 1989. This is also a conservative estimate of the increased cost for fire safety mitigation, since it does not include the cost of the fire-stopping systems themselves or the increase costs of the special installation methods required for such systems.

Currently, the costs of CPVC are not significantly lower than copper. Dickens presented an analysis comparing the material costs of the copper and CPVC (Attachment F, Dickens, Appendix A, p.15-16), which showed CPVC to be more expensive than copper at that time. The cost of CPVC resin has dropped; the cost of copper fluctuates with a world market and both CPVC and copper are going to be at a cost disadvantage to the definitely cheaper polybutylene (PB) or PEX pipe. This analysis was updated using 1997 costs of copper and CPVC (see Attachment G). The updated analysis shows that there is only a $57.00 material savings by using CPVC.

If the EIR is going to present a favorable discussion of CPVC over copper piping based on affordability, then it must present a table showing a cost comparison for installing the two different materials. The cost comparison must incorporate (and clearly specify) all proper installation procedures for each material from beginning to end (including inspections, fire blocking material, etc.).

True life-cycle cost will depend on the installed life of the plumbing system. In the EIR, the claimed estimated life span of CPVC is not based on any supportable data. The DEIR states that: "CPVC has an estimated service life of 75 years, although this is only an estimate since CPVC has only been in use for about half of that time." (DEIR, p.105). What is the source of this estimated service life? Is it just someone's assumption or is it based on field studies or laboratory simulated aging studies? Does any pipe manufacturer, such as B.F.Goodrich or the extruders using B.F.Goodrich resin, offer a 75-year warranty for the product? Does B.F.Goodrich publish information on the conditions that may shorten pipe life? Simply put, if there is no data to support the 75 year estimate, a more conservative figure should be used. The EIR must substantiate its 75-year life span projection.

B. Construction Cost Savings Do Not Mean Savings to the Consumer

Even if CPVC were significantly cheaper than copper, this would not produce "affordable" housing for California citizens. The EIR states that allowing CPVC will further the goal of providing affordable housing, but the EIR does not show how reducing the cost of plumbing materials and installation actually effects cost of a house when it is sold. According to Dickens:

> "When any amount of a good can be produced at a fixed cost that cost will determine the goods price. However, when the quantity of a good that can be produced is limited, the price will be determined by the demand for the good. The cost of producing it will be irrelevant to the selling price. It seems reasonable to assume that in many urban areas in California all land within normal commuting distance of the central city has been developed and the quantity of housing available to those who wish to work in the central city is essentially fixed. In such an environment the price of housing, even the price of a new house constructed on an old lot, will be unaffected by the cost of building the new housing. Rather, any reduction in construction costs will simply increase the value of land. Only in rural areas or in urban fringe areas (where housing costs are relatively low) is it likely that the cost of building new housing will affect the price of housing.
>
> The same should be true for rent. In fully developed urban areas (where rents are highest) rent is probably unaffected by the cost of constructing new rental housing and is determined only by the demand for housing. Again, savings on construction costs will only increase the value of land" (Dickens, p. 9-10).

If there are any cost savings with CPVC pipe, they will benefit the contractor or home builder and not the consumer. Indeed the consumer will have very little choice over what plumbing materials are installed in anything other than custom homes. Another myth is that putting plastic pipe in the marketplace will add to consumer choice. According to the DEIR: "Allowing consumers to choose pipe with the longest life span in their home's location is consistent with the general public policy goal of providing California families with safe, decent, and affordable housing (DEIR, p.106). This statement is totally misleading because consumers do not get the choice of what plumbing material is used when a house is newly constructed. The contractors/developers get the choice of what building materials to use. EIR text referring to housing affordability because of use of CPVC piping should be removed from the EIR.

C. Mechanical Failure and the Consumer

Arguably mechanical failure of potable water plumbing systems would lead to direct impacts on the physical environment, but we choose to discuss it under the heading of socioeconomics because it is a component related to consumer issues.

At several places in the EIR, great emphasis is placed on problems with copper corrosion where aggressive water is used for potable water. Replacement of copper by plastic is the sole approach contemplated by the EIR. The EIR should also include, however, a broader range of options to reduce copper corrosion. The relevance of this should be obvious because even with adoption of the proposed code change, there will be literally millions of homes with copper plumbing already throughout the state. Whatever legitimate consumer or environmental problems are associated

with copper, they will not disappear with HCD's action.

For this reason the EIR needs to take a broader look at the issues of corrosion that it identified. Rather than simply pointing to copper corrosion as one of HCD's motivations for the project, the EIR should identify alternatives including water treatment and the costs associated with them. The EIR should address the potential community wide impact on funding for water treatment for newer homes being built with plastic versus older homes built with metal. HCD obviously views plastic pipe as a quick fix for aggressive water, but what about existing structures?

CPVC has been around for a long time as a plastic, but the aggressive development of CPVC piping for industrial and residential use began in the 1980s with B.F.Goodrich's establishment in the marketplace. The EIR authors seem to think that CPVC has an extensive track record, but present very little information on the actual extent of long-term installations. Citation of a few demonstration homes plumbed many years ago is hardly relevant. Citation of the "other 49 states" doesn't really show the basis for comparison of the extent of consumer testing of CPVC compared with far more broadly used metal. B.F.Goodrich should be a source of this information, but HCD will need to objectively review anything provided to be able to discern fact from marketing.

This information is relevant because the dramatically different extent of the installed base of copper and CPVC affects all of the statistics that HCD quotes in the EIR. Any listing of worker injuries is statistically meaningless without showing the extent of the population generating the statistic.

HCD needs to present information on failures of CPVC systems – either based on actual failures in the field or known limitations to CPVC. The EIR dwells at great length on copper corrosion (e.g. pp. 89 – 91), but never presents information about CPVC. B.F.Goodrich, HCD's primary source of information, could have provided an objective description of CPVC limitations, special installation requirements, and known problems in the field. HCD could have presented this information side-by-side in EIR, and the public at least would have seen that there is a significant potential for failure due to incompatible materials, incorrect installation, and exposure to high temperatures. B.F.Goodrich's installation guide for its product includes some of these known limitations (Attachment C).

CPVC's parent material PVC is not suited to hot water service because it loses strength at elevated temperatures. The process of post-chlorination of PVC to produce CPVC pipe progressively raises the softening temperature and brings the resin into the range of thermal performance suitable for hot water service in residential installations. The EIR should disclose that CPVC pipe is operating at the extreme high end of its rated temperature range and that this leaves no margin of safety for even momentary heat exposure such as from a malfunctioning water heater or from a homeowner attempting to thaw a frozen pipe. Some of the installation restrictions seek to limit the potential for damage, but these only underscore the fact that the hot water connection is the weak link in a CPVC system.

The EIR should note that CPVC will be subject to less reliability when installed in cold weather. Cold weather can affect the CPVC assembly because the solvent cements must be used in a narrow temperature range — well above freezing. The solvent cement manufacturers warn

against cementing pipes below 40^0 F and there are low temperatures cements manufactured presumably with a different mix of solvents. If the joint is too cold it will not set properly, the joint may be mechanically deformed before it sets, and the solvent will eat deeper into the pipe and produce a weaker joint. If solvent cement freezes, the consistency will change and subsequent use may produce weak joints.

There is a long list of incompatible materials, materials whose chemical composition is capable of attacking CPVC resin and altering its mechanical performance either through softening or through swelling and subsequent stress cracking. The EIR should disclose that long term exposure of a CPVC plumbing system to potentially incompatible materials will result in failure. There is very little experience with a solvent welded thermoplastic piping system in a home that operates under pressure. The thermal resistance and mechanical strength of CPVC depend critically on its mass of incorporated chlorine and is sensitive to the effect of absorbing any foreign substance. Chemically, CPVC is resistant to aqueous acids or alkalies, but is highly susceptible to attack by organic solvents and oils. If exposed to these materials, the pipe system will weaken and fail. The joints are most susceptible because the connection is only formed by the mingled pipe surfaces softened by the solvent.

B.F.Goodrich acknowledges a short list of obviously incompatible materials (Attachment C), but there are undoubtedly more. Home construction relies on sealants, adhesives, surface coatings, insulating foams, plastic fixtures, etc. Substances not normally thought of as solvents will attack CPVC such as vinyl plasticizers used to make flexible PVC products. If in contact with CPVC piping, the PVC plasticizers could migrate into the CPVC and weaken the pipe. The exposure could occur from vinyl-coated pipe hangers or from contact with other materials. Other oils or adhesives such as the binder on fiberglass insulation and water vapor barriers may slowly degrade CPVC.

Interestingly, HCD has access the information on incompatibility and failure from environmental exposure of CPVC to chemicals. On page 62, the EIR discusses permeation and mentions the failure of several homes in Florida where CPVC pipe was exposed to a termiticide. HCD reassures the reader without evidence that the termiticide could not have permeated the pipe and that the only problem was that the pipe failed. HCD's careful consideration of the limitations stated by B.F. Goodrich (Attachment C) is needed. Does HCD have information of sources of chemical damage to CPVC not included in the list in Attachment C?

The problem in Florida is associated with several commonly used termiticides, notably chlorpyrifos (Dursban), but may also be related to exposure to the petroleum based carrier as well as to the active ingredient. The same chemicals are registered for use throughout the United States and the same slab on grade construction is used extensively in California.

HCD should list which chemicals are known to be incompatible with CPVC

a) What chemicals are considered incompatible with CPVC plastic pipe?
b) What kind of effects can these incompatible chemicals have on CPVC?
c) Are any of these chemicals found in common household materials?
d) What kind of remediation can be done when the pipe system is found in contact with incompatible materials or to have been exposed? Should the homeowner wait for failure or would damage stop when the incompatible material is removed?

e) What measures will HCD implement to make sure that this problem is minimized?

8. Solid Waste

The EIR makes several assumptions about future recycling of CPVC piping from the waste stream that are not supported by factual information. The DEIR must provide supporting information for the conclusion of no significant impact by providing background information on plastic recycling from the waste stream. Specifically, the EIR must provide information on the following issues:

a) The DEIR must estimate the potential waste stream created by allowing CPVC in California by projecting the amount of material that would eventually be added to the waste stream (in pounds per day or tons per year). This issue cannot be cast aside as speculative simply because the estimated useful life of CPVC is "more than half a century".

b) The EIR states that because PVC is currently recycled, CPVC will also be recycled. The EIR should provide information regarding the amount and type of current PVC recycling. How is it separated from the waste stream (source separated or extracted from a mixed waste stream)? Are recyclers spread throughout the state or is the plastic shipped to few regional recyclers?

c) What is the market for recycled PVC? Can recycled PVC compete with virgin PVC resin and is the recycled PVC market artificially supported by industry or government sponsored recycling programs? Would the recycled market be the same for CPVC resin?

d) According to the Lead Agency, CPVC has been in use everywhere else in the world except for California. If this is the case, there must be some information regarding the market and recycling methods of CPVC. What portion of CPVC is recycled from the waste stream in other states (or countries) that currently allow its use? How does the price of recycled CPVC compare to the price of virgin CPVC (which will be the ultimate factor driving the recycling of CPVC)? What kinds of products are made out of the recycled CPVC (other than those already listed in the EIR).

e) The DEIR should examine the effect on CPVC use on recycling of demolition debris and interference with AB 939 waste reduction goals.

f) What effect will recycling CPVC have on the constituents of plastic pipe? Will recycled resin be usable for pipe? Will the properties of thermal stabilizers and the high extrusion temperatures needed for CPVC result in CPVC mixed with PVC making it difficult to recycle PVC itself? HCD should refer to industry literature for this.

In preparing the DEIR, it appears that the authors overlooked information regarding plastic recycling contained in two of the sources listed in the EIR's bibliography. In reviewing these sources published by the California Integrated Waste Management Board (CIWMB), several pieces of information regarding the current state of plastics recycling came to light:

- The U.S. EPA estimates that 19.3 million tons of plastic waste were generated in

the U.S. in 1993. Of that amount, only 0.7 million tons were diverted from disposal, only 3.5 percent of the amount generated. In California, the plastic waste diversion rate was 2.9 percent in 1990 (Integrated Waste Management Board, 1996, HCD-109, p.1). The plastics recycling industry is relatively immature compared to other materials such as glass, paper and aluminum which are recycled at rate of 22 percent, 34 percent and 26 percent respectively.

- While there has been some success with recycling plastic materials such as PET and HDPE, there has been less success with PVC. According to the California Integrated Waste Management Board:

  "Markets for recycled PET are currently the largest and most developed. However, the vast quantities of HDPE used in consumer products will support increasingly large markets for HDPE. Other common resins - such as polystyrene, LDPE, polypropylene, and PVC - continue to face collection, separation, and contamination problems that curtail the development of markets" (Integrated Waste Management Board, 1992, HCD-107, p.52).

- Postconsumer plastic recycling, however, still is experiencing significant growing pains because of several barriers:

  - ☐ Expensive technologies are necessary to clean and separate the different plastic wastes. Although increasing progress is being made in separation and reprocessing technologies, most solutions are costly.

  - ☐ Labor costs are high because many plastics must be manually separated.

  - ☐ The market for recycled resins is limited by seasonal fluctuations that lead to an unstable supply, sharp fluctuations in prices for virgin resins, volatile foreign markets, and uneven quality of collected plastic waste because there are no widely accepted standards.

  - ☐ "Transportation costs generally are high for plastics due to their low weight and high volume. The amount that any given container can haul is limited without first incurring the cost of compressing and baling" (Integrated Waste Management Board, 1992, HCD-107, p. 2).

While the information contained in these two references does not necessarily indicate the state of plastics recycling "more than half a century" from now when the DEIR predicts CPVC will begin to enter the waste steam in appreciable quantities, it does indicate the current state of plastics recycling and the difficulties that must be overcome before a strong and comprehensive plastics recycling industry exists. These two documents do not necessarily support the EIR's conclusion of no significant impact because CPVC piping will be recycled.

First the EIR must tell the public how much CPVC waste is expected to enter the waste stream, then the EIR must discuss the practicality of recovery of most of the CPVC in the waste stream through recycling before a conclusion of no impact can be supported.

If California's 1990 plastic waste diversion rate was 2.9 percent, that means that roughly 97% of plastic wastes generated were disposed of in landfills. The widespread use of a material that is difficult to recycle and will most likely be landfilled is not consistent with the goals of AB 939 which directs cities and counties to reduce the waste stream to landfills by 50% by the year 2000. AB 939 also presents a waste management hierarchy which places source reduction above recycling. Since copper piping is a proven product for potable water systems and there exists a proven market for recycled copper piping, HCD must address the CPVC piping and its consistency with the waste management goals established by AB 939.

9. The Effects of Leaching on the Physical Environment

The potential impacts of water leaching on the physical environment are not addressed in the DEIR. Cumulatively, solvents, organotins, or other substances leaching from CPVC pipe will pass into the wastewater and reach the environment.

While the DEIR addresses in detail the leaching impacts of copper piping on the physical environment, it completely ignores the leaching impacts of CPVC piping. There is no discussion of the potential of leachates from CPVC to impact the physical environment. At a minimum the following issues should be addressed for each of the potential contaminants leached from CPVC:

- the amounts of the leached contaminants should be estimated;
- the potential toxicity of the contaminants on the aquatic environment;
- the sensitivity of receiving environments, such as rivers, bays, estuaries and the ocean (any water bodies where sewage treatment plants discharge);
- Any water quality standards relevant to these contaminants should be discussed;
- the estimated amount of contaminant discharge should be compared to existing standards;
- Relevant studies that address the impacts of these contaminants on the physical environment should be presented;

The following impacts should be addressed as stated above.

Organotin leaching impact on environment has not been addressed. The potential for organotins leaching into the water discharge system into the sensitive marine habitats, such as the South Bay, has not been addressed. The DEIR claims that CPVC is required to reduce impacts of copper leaching on the South Bay, but does not address the impact of exchanging one leachate for another.

1. The potential impact of dibutyltin and monobutyltin on marine organisms has been completely ignored.
2. There has been no attempt to estimate the amount of loading of organotins into sensitive environments such as the South Bay. The DEIR goes into great detail regarding the amount of loading of copper pipe leachates on the South Bay but does not even attempt to address organotin loading.

Consider that each household constructed with CPVC pipe will include approximately one pound of organotin compounds in the pipe matrix. This organotin material will become a permanent

part of the aquatic environment – that is to say it as the potential to leach small but steady amounts of organotin into the water system. Even assuming the low levels of organotin posture late in EIR, the cumulative leaching could be substantial. The EIR should contain at least an estimate of this quantitative impact. Does the high chlorine residual of the disinfection process result in greater organotin leaching? What is the effect of this amount of tin on the aquatic environment of the South Bay?

Potential dioxin impacts on the environment have not been addressed in the DEIR. Dioxins or more specifically dibenzofurans were found in pipe tested (see attachment P). Although this test does not demonstrate leachability in raises an issue that should be addressed in EIR. Additionally the potential of chlorinated vinyl in pipe manufacture or in the waste stream may also be a source of dioxins (see attachment A).

As with the organotin case above, there has been no attempt to estimate the amount of loading of dioxins into sensitive environments such as the South Bay. This is particularly important since the U.S. EPA is expected to reverse the Water Resources Control Board's decision not to list dioxin as a high priority pollutant for the San Francisco Bay under the Clean Water Act (See Attachment H: Inside Cal/EPA, July 10, 1998, p.8).

10. Energy, Manufacturing and the Environment

The EIR addresses energy on pp. 50-51 with the observation that CPVC is made from LPG gas and salt. This over simplification misses some of the energy and environmental costs associated with the production of CPVC resin and its extrusion into pipe products. Chlorine makes up the majority of CPVC by weight as it is manufactured by the chlor-alkali process from electrolysis of concentrated brine. Production of the brine through electrolysis itself and processing chlorine are all highly energy intensive. For completeness in its discussion of LPG energy impacts, the EIR should note the electrical and other energy requirements of the chlor-alkali side of the product. Further energy is required to produce PVC monomer, to complete the chlorination process and later to manufacture the pipe directly. The EIR analysis only addresses the energy content of a petrochemical raw material and not the total energy cost of the product.

The EIR briefly addresses the waste and environmental impact of CPVC manufacture (P. 52). Probably the most significant environmental impact comes from the earlier stages of chlorine and PVC monomer manufacture. These impacts have been the subject of substantial environmental concern from public interest groups and have been associated with some of the most significant incidence of toxic contamination in the U.S. While these precursor impacts are broadly disseminated and perhaps the CPVC component of PVC manufacture is small, for completeness, EIR should acknowledge these life-cycle environmental effects.

Further in the discussion of energy, EIR notes, "In order to achieve a reasonable level of energy efficiency, many residences have plastic insulation installed on copper pipes." (P. 52) Is it HCD's interpretation of the California energy conservation regulations that CPVC pipes used for hot water will not need to be insulated? Are all available insulation materials compatible with CPVC?

Thomas S. Reid, Professional Experience

General Expertise

Thomas S. Reid has directed his firm and participated in much of its technical work since its inception in 1972. He has managed the performance of work on over 400 environmental impact assessments and other technical studies. Many of these studies involved industrial, energy, or waste management projects that had significant issues regarding air pollution, air toxics, water quality, public health, public safety, or risk of upset.

Mr. Reid is well versed in the physical aspects of environmental analysis and conservation planning. He has expertise in the areas of air and water chemistry, noise assessment, engineering aspects of projects and computer modeling in impact assessment. Applied skills include aerial photo interpretation, geographic information systems (GIS), CAD-assisted mapping, data processing and interpretation, and statistics. His work in air quality modeling, monitoring and impact assessment has special expertise for fugitive dust, fine particulate, crystalline silica and asbestos.

Education:

B.S. Chemistry, Yale University, New Haven, CT, 1969.
Graduate study in Biology, Stanford University, Stanford, CA, 1969-1973.
National Science Foundation Graduate Fellowship, 1969-1972.

Membership:

Association of Environmental Professionals, 1974
American Chemical Society, 1976
Air and Waste Management Association, 1986

Professional experience in assessment of Industrial, Energy and Waste Management Projects

- Oil Transshipment and Refining
- LNG Transshipment/regasification
- Oil and Gas Pipelines
- Petroleum Extraction and Enhanced Recovery
- Underground Natural Gas Storage
- High-voltage Transmission Lines
- Water Supply Systems
- Processing and Warehousing Facilities
- Cyanide Manufacturing
- Lumber Mills
- Steel Rolling Plants
- Research and Development Laboratories
- Bioengineering Laboratories
- Aggregate Quarries and Riverbed Mining
- Underground Mineral Mining
- Wind Energy Facilities
- Geothermal Energy Plants
- Biomass Energy Plants
- Waste to Energy Plants
- Coal-fired Energy Plants
- Petroleum Coke-fired Energy Plants
- Tank Farms
- Communication Towers
- Sanitary Landfills
- Industrial Waste Disposal Sites
- Wastewater Treatment Programs
- Transfer Stations/materials Recovery
- Construction Waste Recycling
- Franchise Collection
- Green Waste Composting
- Hazardous Waste Collection, Treatment and Disposal

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Comments of

California Pipe Trades Council
California Firefighters Association
California Legislative Conference of the Plumbing, Heating and Piping Industry
Mechanical Contractors Association of Northern California
Richard Cuffe, Greg Baker, Ron Morgan and Sam Gill

on the

DRAFT
ENVIRONMENTAL IMPACT REPORT
FOR
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE
USE FOR POTABLE WATER PIPING IN RESIDENTIAL BUILDINGS

ATTACHMENTS TO THE COMMENTS
OF
THOMAS REID ASSOCIATES

August 29, 1998

List of Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

A) Gesellschaft fur Arbeitsplatz und Umweltanalytik "Orientational air studies for PCDF/D during the extrusion of C-PVC"

B) BF Goodrich " Patents: No. 5,591,497, No. 5,194,471, No. 4,377,459"

C) Excerpts from BF Goodrich "Flowguard Gold" FG-2G re: Cold Weather Considerations and Chemical Compatibility of FlowGuard Gold CPVC Products

D) USEPA letter to Unibell PVC Pipe Association re: vinyl chloride contamination of a Kansas public water supply, April 1, 1993

E) European Council of Vinyl Manufacturers website: www.pvc.org, "Question and Answer Page"

F) Dickens, "Costs of Plastic Pipe Not Considered or Inadequately Analyzed in the Draft Environmental Impact Report on Plastic Plumbing Pipe"

G) Thomas Reid Associates, "Material Cost Comparison: CPVC vs. Copper Plumbing" August 21, 1998

H) Inside Cal/EPA "EPA Region IX Poised to Reverse Water Board Decision on Dioxin" July 10, 1998

I) Thomas Reid Associates, "Solvent Content of Cement and Primer Comparison" August 21, 1998

J) Ron Coiner Deposition, BF Goodrich vs. Village in the Lake in the Hills, Sept. 3, 1997

K) Ron Coiner Deposition, BF Goodrich vs. Village in the Lake in the Hills, March 24, 1998

L) NSF International, NSF Tetrahydrofuran Task Group, "Minutes for the July 10, 1997 Task Group Meeting" July 25, 1997

M) British Standards Institute, "Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of water, Part 4. Method of Test - The GCMS identification of water leachable organic substances" 1998

N) Seinen, et al, "Toxicity of Organotin Compounds. II. Comparative in Vivo and in Vitro Studies with Various Organotin and Organolead Compounds in Different Animal Species with Special Emphasis on Lymphocyte Cyctotoxicity" April 4, 1977

O) 1998 Testing Results, Anresco Incorporated

P) 1998 Testing Results, Quanterra Environmental Services

Q) 1998 Testing Results, West Coast Analytical Service, Inc.

R) 1998 Testing Results, TRI/Environmental, Inc.

8/26/98

A

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT A

Gesellschaft fur Arbeitsplatz und Umweltanalytik "Orientational air studies for PCDF/D during the extrusion of C-PVC"

TRANSLATION:

Gesellschaft für Arbeitsplatz- und
Umweltanalytik mbH
Otto-Hahn-Strasse 22
4400 Münster-Roxel

Wacker Chemie GmbH
Werk Burghausen
Attn.: Mr. Schadhauser
Johannes-Hess-Strasse 24
8263 Burghausen

Direct Dial: 247

November 22, 1991

Re.: Orientational air studies for PCDF/D during the extrusion of C-PVC; your ref.: WB-J/Tf; our ref.: Ki-9108—0627—02.

Dear Mr. Schadhauser:

In reference to your commission of August 2, 1991, we are sending you attached the results of the study of the process indicated above and our bill.

We would be glad to answer any questions you might have.

Sincerely,

E. Balfanz

/signature/

for the company: Dr. H. Kieper

Encl.

A P P E N D I X

to the GfA Letter of November 22, 1991 to Mr. Schadhauser,

8263 Burghausen

1. GOAL OF THE INVESTIGATION

At the Gehr plastics plant in Mannheim, both highly chlorinated C-PVC and standard PVC are extruded in the extrusion shop. At the request of Wacker Chemie GmbH in Burghausen, orientational air samples were to be taken to determine the extent to which the air in the shop and in the vicinity of the C-PVC extruder is contaminated with PCDF/D during production. These sample were to be analyzed with respect to the following parameters:

PCDF:
- total tetraCDF
- total pentaCDF
- total hexaCDF
- total heptaCDF

- 2378-tetraCDF
- 12378-/12348-pentaCDF
- 23478-pentaCDF
- 123478-/123479-hexaCDF
- 123678-hexaCDF
- 123789-hexaCDF
- 234678-hexaCDF
- 1234678-heptaCDF
- 1234789-heptaCDF
- 1234789-octaCDF

PCDD:
- total tetraCDD
- total pentaCDD
- total hexaCDD
- total heptaCDD

- 2378-tetraCDD
- 12378-pentaCDD
- 123478-hexaCDD
- 123678-hexaCDD
- 123789-hexaCDD
- 1234678-heptaCDD
- 12346789-octaCDD

toxicity equivalents (TE's):

according to BGA [Federal Health Agency] 1984,

according to NATO/CCMS 1988.

2. DESCRIPTION OF THE SITE

Both standard PVC and, at regular intervals, highly-chlorinated C-PVC are extruded in the extrusion shop at Kunststoffwerke Gehr. A total of 8 extruders are available in the shop for extrusion. They are used to produce both PVC sections and round bars, but as a rule only one of the them is used to extrude C-PVC. The starting material is PVC or C-PVC granulate, which is subjected to a thermal load of up to 150°C during extrusion. According to the operator of the plant, the production level per extruder averages 25 kg of granulate per hour for standard PVC and 15 kg of granulate per hour for C-PVC. The hall has a floor space of about 300 m^2 and does not have an exhaust system.

2. SAMPLING

After discussion with the client, two air samples were taken in the extrusion shop during the course of extrusion of PVC and C-PVC in the period of August 21—22, 1991 between 3:00 p.m. and 9:45 a.m. One of these was a cross-sectional sample of the shop air, for which individual samples were taken at three different points in the shop at parallel times. These individual samples were then combined to form a total sample. The other air sample was taken from a point directly above the head of the extruder (distance, about 20 cm) in which C-PVC was being processed. During the sampling, most of

which occurred during the night shift (from 6 p.m. to 6 a.m.), 7 extruders were in operation, although only one of them was extruding C-PVC. According to the plant operator, a total of 32 m of round C-PVC bars were produced during the night shift. Further details of the sampling procedure are given in Table 01.

Sampling was done on the basis of VDI Guideline 3498 with so-called small-filter units from Derenda, Berlin, which allow an air throughput of about 3 m^3/h. A combination of glass fiber filters and polyurethane foams connected downstream was used as a sorption system, so that the PCDF/D component of the air able to pass through the filter could also be detected.

In addition to the air samples, 3 material samples were taken as backups for possible later analysis. Included were samples of the C-PVC granulate used, an extruded round bar of C-PVC, and a thermally stressed C-PVC residue which had become stuck to the extruder head.

4. SAMPLE PREPARATION AND ANALYSIS

The 3 room air samples from the extrusion shop were combined before analysis into a mixed sample (WCG 01). After the addition of ten ^{13}C-labeled PCDF/D standards (one substance per group of homologs to be analyzed), each of the two samples (WCG 01 and 02) was extracted for 24 h with toluene in a Soxhlet extractor.

After several chromatographic purifications, PCDF/D was determined by capillary gas chromatography. As a check on the quality of the workup, the recovery rates of the ten ^{13}C-labeled standards were determined by means of 4 additional ^{13}C-labeled PCDF/D standards, which were added to the PCDF/D-containing fraction at the end of the sample workup. A system consisting of

an HP 5890 gas chromatograph coupled to a VG-AutoSpec high-resolution mass spectrometer was used for the analysis. The following conditions were used: KAS injection; injected sample volume, 5 µL. Solvent: toluene. GC column: 60 m × 0.25 mm; phase, SP 2331; film thickness, 0.2 µm. Carrier gas: He, 180 kPa. GC temperature program: 2 min at 80°C, isothermal; to 200°C at 20°C/min; 1 min at 200°C, isothermal; to 250°C at 4°C/min; 70 min at 250°C, isothermal. Temperature of the transfer line: 250°C. Source temperature: 250°C. Ionization: EI, positive. Reference substance: PFK (perfluorokerosene). Resolution, 8,000. SIR mode. 3 masses per homolog group. Time windows established.

The variables listed in Section 1 were determined quantitatively. To calculate the toxicity equivalents (TEs), the factors summarized in Table 02 were used.

As also described in the literature, it is not possible to separate 12378- from 12348-pentaCDF or 123478- from 123479-hexaCDF on the GC phase SP 2331. The total value given in each case can also be considered the maximum value for the congener in question.

The recovery rates for the $^{13}C_{12}$-labeled tetra- to hexaCDF/Ds added before workup were as a rule over 80%.

5. RESULTS

As Table 03 shows, PCDF/D of almost every degree of chlorination could be detected in both air samples from the extrusion shop.

With respect to the distribution of the PCDF homologs, it is conspicuous that, in sample WCG 01, the tetra- to heptaCDFs are present in comparable quantities, whereas in sample WCG 02, the degree of PCDF contamination

decreases considerably with increasing degree of chlorination. Furthermore, the total concentration of the PCDFs in sample WCG 02 is higher by about a factor of 3. As for the PCDD values, both samples show as a rule an increase in contamination with increasing degree of chlorination. The total PCDD concentrations in both samples are on the same order of magnitude.

The mass fragmentograms of the PCDF homolog groups show a specific distribution pattern, especially in the case of tetraCDF, in which various isomers occur as the primary components. This trend is especially pronounced in the air sample taken from above the head of the extruder (WCG 02).

The differences in the homolog distributions and in the mass fragmentograms of the tetraCDFs found in the two air samples indicate that the extrusion of C-PVC is not the only source of PCDF contamination of the shop air.

When we take the TE value according to the BGA model, which incorporates the different toxicities of the individual PCDF/Ds (see Table 02), and use it to categorize the results quantitatively, we find that the PCDF/D contamination of the shop air at 0.41 pg TE/m^3 is in the upper range of variation of outside air of average contamination in large congested urban areas (usually 0.1—0.4 pg TE/m^3). Directly above the head of the extruder (distance, 20 cm), the air pollution during the extrusion of C-PVC was about 2.5 times greater with a value of 1.03 pg TE/m^3. The air contamination above the other extruder heads during the processing of standard PVC is not known at present.

No further conclusions concerning, for example, the contributions of other potential sources to the detected PCDF/D contamination of the shop can be made on the basis of the present data. Information useful in clarifying this question could be derived from, for example, comparative material studies

of extruded PVC and C-PVC and from studies of the air during the extrusion of standard PVC.

An evaluation of the results in terms of the occupational hygiene of the air can be done only by a toxicologist familiar with the problems in this area.

Münster-Roxel, November 22, 1991

E. Balfanz

/signature/

for the company: Dr. H. Kieper

TABLE 01. AIR SAMPLING DATA FOR THE SAMPLES TAKEN IN THE EXTRUSION SHOP OF KUNSTSTOFFWERKE GEHR IN MANNHEIM ON AUGUST 21–22, 1991. KEY: (a) sample no.; (b) sampling site[a]; (c) sampling time; (d) volume of air collected, m^3; (e) extrusion shop, mixed sample from 3 different areas; (f) granulate storage; (g) electrical box on inside wall; (h) workbench near product storage; (i) 20 cm above the head of the extruder used for processing C-PVC; and (j) to.

Probenbezeichnung (a)	Probenahmeort[a] (b)	Probenahmedauer (c)	gesammeltes Luftvolumen [m^3] (d)
WCG 01	Extrusionshalle, Mischprobe aus 3 (e) Hallenbereichen:		
	Granulatlagerplatz (f)	21.08.: 15.05 bis (j) 22.08:: 09.30	56,23
	E-Kasten an der (g) Innenwand	21.08:: 15.06 bis 22.08.: 09.33	53,80
	Werkbank im Bereich der Produktlagers (h)	21.08.: 15.07 bis 22.08.: 09.35	61,13
			Σ 171,16
WCG 02	20 cm über dem (i) Extruderkopf der C-PVC-Verarbeitung	21.08.: 15.10 bis 22.08.: 09.45	53,01

[a]Room temperature during sampling: 21–32°C.

TABLE 02. 2378-tetraCDD TOXICITY EQUIVALENT FACTORS (TEFs). KEY: (a) model; and (b) total.

Modell (a)	BGA 1984	NATO/ CCMS 1988
2378-TetraCDD	1,0	1,0
12378-PentaCDD	0,1	0,5
123478-HexaCDD	0,1	0,1
123678-HexaCDD	0,1	0,1
123789-HexaCDD	0,1	0,1
1234678-HeptaCDD	0,01	0,01
OctaCDD	0,001	0,001
2378-TetraCDF	0,1	0,1
12378-PentaCDF	0,1	0,05
23478-PentaCDF	0,1	0,5
123478-HexaCDF	0,1	0,1
123678-HexaCDF	0,1	0,1
123789-HexaCDF	0,1	0,1
234678-HexaCDF	0,1	0,1
1234678-HeptaCDF	0,01	0,01
1234789-HeptaCDF	0,01	0,01
OctaCDF	0,001	0,001
Summe TetraCDD	0,01	0
Summe PentaCDD	0,01	0
Summe HexaCDD	0,01	0
Summe HeptaCDD	0,001	0
(b)		
Summe TetraCDF	0,01	0
Summe PentaCDF	0,01	0
Summe HexaCDF	0,01	0
Summe HeptaCDF	0,001	0

The TE value of a sample is calculated by multiplying the concentrations in question by the associated TEF and by adding the products. Note that the total values used do not include the 2378-C_i-substituted congeners of this group of homologs.

TABLE 03. PCDF/D CONCENTRATIONS IN WORKPLACE AIR. CLIENT: WACKER CHEMIE GmbH. SAMPLING SITE: KUNSTSTOFFWERKE GEHR, MANNHEIM. KEY: (a) sample no.; (b) total; and (c) to.

	Probenbezeichnung (a)	WCG 1	WCG 2
	PCDF/PCDD	pg/m³	pg/m³
(b)	Summe TetraCDF	2,12	16,3
	Summe PentaCDF	2,55	7,4
	Summe HexaCDF	2,87	4,2
	Summe HeptaCDF	1,65	2,3
	OctaCDF	< 0,83	< 1,1
(b)	Summe Tetra- bis OctaCDF (c)	9,19	30,2
	2378-TetraCDF	0,174	2,17
	12378-/12348-PentaCDF[a]	0,210	1,87
	23478-PentaCDF	0,269	0,56
	123478-/123479-HexaCDF[a]	0,841	1,05
	123678-HexaCDF	0,282	0,42
	123789-HexaCDF	0,057	0,14
	234678-HexaCDF	0,287	0,39
	1234678-HeptaCDF	1,159	1,62
	1234789-HeptaCDF	0,118	0,14
(b)	Summe TetraCDD	0,23	0,6
	Summe PentaCDD	0,89	1,2
	Summe HexaCDD	2,55	2,8
	Summe HeptaCDD	1,98	2,3
	OctaCDD (c)	3,98	4,7
	Summe Tetra- bis OctaCDD	9,63	11,6
	2378-TetraCDD	< 0,006	0,01
	12378-PentaCDD	0,070	0,07
	123478-HexaCDD	0,131	0,10
	123678-HexaCDD	0,326	0,36
	123789-HexaCDD	0,231	0,17
	1234678-HeptaCDD	1,167	1,37
(b)	Summe Tetra- bis OctaCDF/D (c)	18,82	41,8
	TE (BGA 1984)	0,401	1,03
	TE (NATO/CCMS 1988)	0,441	0,93
	TE (NATO/CCMS incl. NWG)	0,448	0,94

Unless otherwise indicated, undetected congeners or homolog groups are not included in the total values or toxicity equivalents (TEs).

(a) Congeners which could not be separated from each other by gas chromatography on SP-2331.

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No. of pages, incl. coversheet: 4

An/To: Mr. Frank Wischt

Datum/
Date: July 24, 199
V-UW/Dr.So/se

Firma/
Company: BF Goodrich Co.
Specialty Polymers & Chemicals Division

Stadt/
City: 9911 Brecksville Road
Cleveland, Ohio

Land/
Country: USA

Von/
From: Dr. H. A. Sommer

Fax Nebenstelle/
Personal fax no.:

Betreff/
Subject:

Dear Mr. Wischt,

Please find attached detailed information on the dioxine analytic made by Institut Kuhlmann. For further information please contact directly Dr. Fritz Kuhlmann.

Best regards,

(Dr. H. A. Sommer)

B

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT B

BF Goodrich " Patents: No. 5,591,497, No. 5,194,471, No. 4,377,459"

PROCESS FOR CHLORINATION OF POLY(VINYL CHLORIDE) WITH LIQUID CHLORINE, AND CHLORINATED POLY(VINYL CHLORIDE) COMPOSITION

[FREE-FLOWING MACROGRANULES]

PATENT NO.: 4,377,459
ISSUED: March 22, 1983 (19830322)
INVENTOR(s): Parker, Richard G., Hudson, OH (Ohio), US (United States of America)
ASSIGNEE(s): The B F Goodrich Company, (A U.S. Company or Corporation), Akron, OH (Ohio), US (United
States of America)
[Assignee Code(s): 35360]
APPL. NO.: 6-177,969
FILED: August 14, 1980 (19800814)
U.S. CLASS: 525-239 cross ref: 522-3; 522-5; 522-109; 522-132; 525-192; 525-331.5; 525-356
INTL CLASS: [3] C08F 2-46; C08F 8-22; C08F 12-18; C08J 3-28
FIELD OF SEARCH: 204-159.18; 204-159.17; 525-330; 525-356; 525-358; 525-239; 525-192

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CLAIMS: 20
EXEMPLARY CLAIM: 1
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ART UNIT: 142
FULL TEXT: 892 lines

ABSTRACT

A process is disclosed for the preparation of chlorinated poly(vinyl chloride), (hereinafter "CPVC " for brevity), in the form of free-flowing macrogranules which are derived from solid free-flowing macrogranules of poly(vinyl chloride), (hereinafter "PVC" for brevity), by causing from about 0.6 to about 3.0 parts by weight (wt) of liquid chlorine which are absorbed perunit wt of solid PVC macrogranules to react with the PVC, without shedding reacted material from the macrogranules. The macrogranules of PVC containing absorbed liquid chlorine held therewithin, are maintained in a wetted but free-flowing, apparently dry reaction mass (due to which the process is referred to as "the relatively dry chlorination" or "the low liquid chlorine" process), in a reaction zone maintained at a temperature in the range from about -50 degree(s) C. to about 50 degree(s) C., and a pressure sufficient to maintain the chlorine in its liquid state. The reaction is carried out in the presence of actinic radiation, but without swelling agents and the like. The process may be operated as a batch process, or a continuous process.

The CPVC formed by the process of this invention has improved processing and working characteristics. This CPVC is distinguishable from prior art CPVC compositions by its spectral fingerprint, and by the presence of 5-15 percent by weight (% by wt) of the CPVC as glassy macrogranules.

In another embodiment of the invention, a process is disclosed for simultaneously chlorinating (hence "co-chlorinating") a free-flowing mixture of solid PVC macrogranules and solid polyethylene ("PE") particles, without shedding reacted material from the macrogranules, to yield a mixed reaction product of separate macrogranules of CPVC and particles of chlorinated polyolefin, which mixture, in a preselected ratio of its components, may be directly used in an injection molding machine.

The reaction product formed by the co-chlorination process is visually distinguishable by the characteristic coating of individual CPVC macrogranules with particles of chlorinated polyethylene ("CPE" for brevity).

BRIEF DESCRIPTION OF THE DRAWINGS

The process of this invention will be more readily understood from the following detailed description taken in conjunction with photomicrographs of starting materials, chlorinated products derived therefrom, and schematic illustrations of the process in the accompanying drawings, wherein:

FIG. 1 is a flowsheet schematically illustrating the principal features of a batch process for the chlorination of a relatively dry mass of PVC macrogranules in which is absorbed liquid chlorine.

FIG. 2 is a flowsheet which schematically illustrates the principal features of a continuous process for the chlorination of a relatively dry mass of PVC macrogranules in which is absorbed liquid chlorine.

FIG. 3 is a photomicrograph, enlarged 45 times, of a typical mass of discrete macrogranules of Geon 92* PVC.

*Geon is a trademark of The B. F. Goodrich Company

FIG. 4 is a photomicrograph, enlarged 45 times, of the Geon*92 PVC shown in FIG. 3 above, after it has been chlorinated in the low liquid process of this invention, showing the discrete glassy macrogranules of CPVC scattered among the milky opaque macrogranules of CPVC .

FIG. 5 is a photomicrograph made with transmitted light and enlarged 20

times, of a blend of CPVC macrogranules (smaller images) and CPE particles (larger images). The CPVC is obtained by chlorinating Geon* 103EPF76 PVC in an aqueous suspension, and is commercially identified as Geon*603X560; the CPE is separately obtained by chlorinating PE in another process and is commercially identified as Dow X02243.45 chlorinated polyethylene. The blend has a characteristic photographic image.

FIG. 6 is a photomicrograph made with transmitted light, and enlarged 20 times, of CPVC macrogranules (larger, darker images) obtained by co-chlorinating Geon* 103EPF76 PVC with a finely divided PE, commercially identified as USI Microthene* FA520 polyethylene. Clusters of CPE particles adhere to the CPVC macrogranules, and in addition, CPE particles are profusely distributed within the field of view.

BACKGROUND OF THE INVENTION

The wide use of poly(vinyl chloride) resins (hereinafter "PVC" for brevity), because of their economic availability, is limited to those applications where thermal stability is of secondary importance. In other applications where a thermally stable resin is essential, chlorinated poly(vinyl chloride) resins (hereinafter "CPVC " for brevity), are employed. The chlorination of PVC has been studied in great detail over the past twenty years or so, and numerous chlorination processes have been developed. Most preferred is a process carried out by suspending PVC in water, which PVC is swollen with a lower halogenated hydrocarbon swelling agent, and irradiating swollen PVC with ultraviolet light while bubbling chlorine gas into the water. This process is disclosed in U.S. Pat. No. 2,996,489 to Dannis, M. L. and Ramp, F. L. Several subsequent inventions related to this basic process have been disclosed in the textbooks "Polyvinylchloride und Vinylchloride--Mischpolymerizate," pp 120-125, Springer, Berlin (1951); "Vinyl and Related Polymers," by C. A. Schildknecht (1952); and in U.S. Pat. Nos. 2,426,808; 2,590,651; 3,100,762; 3,334,077; 3,334,078; inter alia. The disadvantage of these liquid-phase processes in which the reaction occurs in a liquid medium, is that (a) chlorine dissolves in water with difficulty, and even at elevated temperature and pressure, chlorinated product forms relatively slowly; and, (b) it is only with difficulty and expense that essentially all the swelling agent used in these processes can be removed from the CPVC product.

Other processes use reaction in a liquid medium without a swelling agent, such as that disclosed in German Pat. No. 2,322,884 published Nov. 22, 1973; U.S. Pat. Nos. 3,506,637 and 3,534,013; inter alia.

Still other less preferred chlorination processes comprise dissolving or suspending the resin in a chlorinated hydrocarbon solvent and promoting the reaction with heat, light, or a catalyst. Yet other processes utilize a fluidized bed of PVC which is contacted with chlorine gas, optionally diluted with an inert gas, and optionally also containing a lower chlorinated hydrocarbon, again catalyzed by ultraviolet radiation. Such processes have been disclosed in U.S. Pat. Nos. 3,532,612; 3,663,392; 3,813,370; Japanese Pat. No. 49-45310; British patent specification Nos. 1,089,323; 1,242,158; 1,318,078; and, German Pat. Nos. 1,110,873; 1,259,573; inter alia. These fluidized bed chlorination processes occur in a gaseous reaction medium, but with difficulty, because of the slow gaseous diffusion of chlorine into solid PVC macrogranules. The term

"macrogranules" is used herein to define a cluster or aggregate of randomly closely packed primary particles of polymer. A handful of macrogranules has the feel of fine sand, and are also referred to as "grains". A macrogranule of PVC or CPVC will typically have an average diameter in excess of 20 microns, with a preponderance of particles in excess of 50 microns in diameter. A preferred size distribution of each macrogranule is in the range from about 50 to about 500 microns, and conventionally ranges from about 100 to about 200 microns. Each macrogranule is made up of a multiplicity of primary particles each in the size range from about 0.05 micron to about 5 microns, and more typically in the range from about 0.5 micron (5000 A) to about 2 microns (20,000 A). The bulk of the primary particles are usually submicronic in size, though conditions of polymerization will determine the actual size distribution of both primary particles, and also, macrogranules. Macrogranules can be characterized by their porosity, that is, internal pore volume, and surface area.

The morphology of PVC and CPVC macrogranules, specifically the porosity and surface area, are important properties which determine the physical properties of the polymer after it is molded. Since CPVC is generally derived by the chlorination of PVC, it has been found that the properties of product CPVC may be tailored to a large extent by precisely controlling the conditions under which precursor PVC is polymerized. Such a process is disclosed in U.S. Pat. Nos. 3,506,637 and 3,534,103. With care, the internal morphology of PVC macrogranules may be particularly tailored to permit relatively fast chlorination in a fluidized bed process catalyzed by actinic radiation. Even so, it is necessary for economy, to practice the process in two stages, as disclosed in U.S. Pat. No. 4,039,732 to Stamicarbon B.V.

I am unaware of any process for the relatively dry chlorination of PVC macrogranules in which only sufficient liquid chlorine ("Cl sub 2 ") is used as will "wet" the macrogranules without any visual appearance of having been "wetted". The terms "wet" and "wetted" are used herein to refer solely to the presence of liquid Cl sub 2 on macrogranules of polymer, and not to the presence of water. When the requisite amount of liquid Cl sub 2 within a narrowly specified range is absorbed by the solid PVC which is then irradiated with actinic (ultraviolet) radiation, there results a reaction in the solid PVC medium which chemically binds a predetermined amount of chlorine in the product CPVC . However, I am aware that it is known to chlorinate solid polyethylene ("PE") by reacting between 5 to 100 parts of liquid Cl sub 2 per part of PE, in a reaction medium of liquid Cl sub 2, until the resulting chlorinated PE (hereinafter "CPE" for brevity) dissolves in the liquid Cl sub 2, and then to recover CPE by evaporating the Cl sub 2. This process is described in greater detail in Canadian Pat. No. 471,037 to John L. Ludlow which teaches a process for the chlorination of ethylene polymers. In this process, PE is suspended in at least 5 parts liquid Cl sub 2 (hence referred to as "the high liquid Cl sub 2 process"), and irradiated with a suitable light source. The chlorination of PE proceeds from the surface inwardly, the chlorinated polymer dissolving from the polymer substantially immediately upon its formation, thereby exposing unchlorinated polymer. In this way the high liquid Cl sub 2 process makes it possible to chlorinate PE polymers at a rapid rate. However, many polymers of monoolefinically unsaturated monomers are not chlorinated in liquid Cl sub 2, or only slightly chlorinated. For example, poly(vinyl fluoride), and poly(vinylidene chloride-vinyl chloride, 88:12) are not

chlorinated; and, as Ludlow taught, unless PE is suspended in at least 5 parts by weight liquid Cl sub 2, there is very little chlorination.

Because of the essential physical difference between liquid Cl sub 2 and gaseous Cl sub 2 (or "vapor Cl sub 2 "), it would not be expected, in the chlorination of crystalline and non-crystalline polymers derived from alpha-beta-monoolefinically unsaturated monomers, to obtain essentially the same freedom of access to the interior portions of the polymers when chlorinating with liquid Cl sub 2, as when chlorinating with vapor Cl sub 2. Expectations relative to freedom of access are further complicated and clouded depending upon (a) the physical condition of the chlorinated exterior portion of the polymer and its ability in such condition either to impede or facilitate travel of liquid Cl sub 2 (or vapor Cl sub 2 in a "dry" process, that is, with non-wetted polymer), and (b) the probability of the chlorinated exterior dissolving into the liquid Cl sub 2 so as to continuously expose unchlorinated polymer. Yet, quite surprisingly, it is found that the rates of chlorination of a mass of PVC grains wetted with liquid chlorine only to the extent that it remains free-flowing with a visual indication of being dry (hence referred to as "wetted but free-flowing"), compared to dry PVC chlorinated with chlorine vapor, are close to being equal under essentially the same conditions of chlorination. This indicates that a vapor phase chlorination of dry free-flowing PVC, and chlorination of wet but free-flowing PVC are essentially analogous in reaction mechanism, and in the progress of each chlorination.

Particularly since Ludlow, supra, teaches the chlorination of ethylene polymers which are relatively crystalline, in a process in which chlorination proceeds in a liquid chlorine medium, it would be expected tht chlorination of polymers such as PVC which are relatively non-crystalline, would proceed more easily in a liquid chlorine medium than a crystalline polymer. It does. Quite unexpectedly however, chlorination of PVC also progresses satisfactorily in a solid reaction medium, this medium being solid polymer. The result is that relatively dry chlorination of a wetted but free-flowing mass of PVC macrogranules may be effected directly, that is, the relatively dry mass of PVC macrogranules is directly converted to a dry mass of CPVC macrogranules. This direct conversion of PVC to CPVC in a solid medium bypasses the problematical recovery of CPVC from a solution of CPVC in liquid Cl sub 2.

Though vapor-phase chlorination of PVC proceeds in the gaseous phase, the quality of CPVC produced is comparable to that produced by low liquid chlorination. This similarity of product quality is thought to stem from a realization of the expectation that the rate of chlorination of relatively non-crystalline polymers, initiated by actinic light, are not diffusion limited because Cl sub 2 molecules are free to gain access to all the interior portions of the polymer. But there was no reason to expect, prior to my discovery, that this freedom of Cl sub 2 molecules would extend to wetted but free-flowing PVC and account for such efficient chlorination. Accordingly, in the prior art, vapor-phase chlorination processes such as are described in U.S. Pat. Nos. 3,532,612; 3,663,392; 3,813,370 and 4,039,732 are preferred.

It was not expected that a wetted but free-flowing relatively non-crystalline massive polymer would be chlorinated so as to remain free-flowing, and resist being converted to a liquid or pasty mass, or to a mass of self-adherent grains because of dissolution in liquid Cl sub 2. Nor was it expected that desired chlorination could be effected without

adversely affecting the physical characteristics so essential to the processability of CPVC in commercial manufacturing operations.

SUMMARY OF THE INVENTION

It has been discovered that solid, discrete, macrogranules of poly(vinyl chloride), hereinafter referred to as "PVC" for brevity, absorb more than their weight of liquid chlorine without forming a slurry. The term "absorb" is used throughout this specification to connote liquid chlorine held or trapped within a macrogranule, regardless of the precise mechanism by which the chlorine is held therewithin. A mass of PVC macrogranules, in which from about 0.1 part to about 3 parts by weight of liquid chlorine are absorbed in about 1 part by weight of PVC, is a wetted but free-flowing mass which visually appears to be dry. The liquid chlorine absorbed in the macrogranules is caused to react with them, in the presence of ultraviolet radiation, at a temperature in the range from about -50 degree(s) C. to about 25 degree(s) C., to yield chlorinated poly(vinyl chloride), hereinafter referred to as "CPVC " for brevity. In the necessarily narrow range of ratios of liquid Cl sub 2 to solid PVC specified, the macrogranules of PVC provide not only a reactant for the reaction, but also provide a solid reaction medium in which the reaction proceeds with unexpected speed. A greater amount of liquid Cl sub 2 than 2:1 will tend to provide a significant liquid medium for the reaction. A lesser amount of liquid Cl sub 2, more than 0.1:1 but less than 0.6:1, produces "lightly chlorinated " PVC . Such lesser amount does not provide enough Cl sub 2 to keep the reaction going at a desirable rate if it is desired to obtain a chlorine content of 65% by wt, or more, in CPVC such as is used for the extrusion of pipe.

It has also been discovered that the direct chlorination of PVC by liquid chlorine in a solid reaction medium may be carried out in the presence of actinic radiation, without using additives such as swelling agents, accelerators and the like, so that the difficult problem of removing the additives from the CPVC product is avoided, not to mention the expense and inconvenience of using them in the first place.

It is therefore a general object of this invention to provide a process for the chlorination of solid macrogranules of PVC in which are absorbed a predetermined amount of liquid chlorine sufficient to convert it to CPVC , but insufficient to provide enough liquid chlorine to produce a wet slurry. The product CPVC so formed generally has substantially lower surface area than the PVC from which it was derived. Unexpectedly, the product CPVC is readily distinguishable over prior art CPVC compositions, both visually and by nuclear magnetic resonance analysis. Under low magnification in the range from about 30X to about 50X it is found that from about 5 to about 15% by wt of the macrogranules are discrete glassy translucent macrogranules easily distinguished from other milky white, opaque CPVC particles. The presence of these glassy macrogranules are characteristic of CPVC powders which have been directly converted from PVC by relatively dry chlorination with liquid Cl sub 2. Spectral data also distinguish the CPVC composition produced by the relatively dry chlorination process of this invention over prior art compositions. A comparison of thermal data for the novel CPVC composition with these data for prior art CPVC compositions, at the same chlorine levels, also clearly distinguishes the one from the others.

It has still further been discovered that the chlorination process of

this invention is readily adaptable to a continuous process in which liquid chlorine is absorbed into macrogranules of PVC near one end of a reaction zone maintained at a temperature in the range from about -50 degree(s) C. to about 50 degree(s) C., and the liquid chlorine-containing macrogranules are agitated as a free-flowing mass in the reaction zone while being exposed to actinic radiation. After a period of time sufficient to convert the PVC into CPVC containing a predetermined amount of chemically-bound chlorine in the CPVC , the desired product may be continuously recovered from near the other end of the reaction zone. By-product hydrogen chloride gas formed during the reaction is removed from the reaction zone; and concurrently evolved chlorine gas is optionally condensed and recycled as liquid chlorine to the reaction zone.

It is therefore a general object of this invention to provide a process for the continuous chlorination of a mass of PVC macrogranules in a solid reaction medium, supplied by the PVC itself, which chlorination is effected by having liquid chlorine absorbed in the PVC macrogranules. Some or all of the chlorine evolved during reaction, may be returned to the reaction zone as liquid which is reabsorbed into the PVC macrogranules so as to maintain a relatively dry, free-flowing mass of macrogranules.

Further, it has been discovered that a mixture of PVC macrogranules and PE particles, in a ratio in the range from about 95:5 to about 85:15 respectively, can be chlorinated under substantially the same temperature and pressure conditions for PVC (by itself) in this low liquid chlorine process, whether or not the process of this invention is practiced batch-wise, or as a continuous process, provided only if the mixture has absorbed therewithin at least 1.5 parts, but no more than 3 parts, by weight of liquid Cl sub 2.

It is therefore a general object of this invention to provide a process for co-chlorinating a mixture of PVC macrogranules and PE particles, in a ratio in the range from about 95:5 to about 85:15, which mixture has absorbed therewithin at least 1.5 parts by wt, but no more than 3 parts by wt of liquid Cl sub 2 ; and also, to provide a novel product especially adapted for use in an extruder, which product comprises coated macrogranules of CPVC visually distinguishable by the cluster of a multiplicity of CPE particles which adhere to each of substantially all the discrete CPVC macrogranules.

DETAILED DESCRIPTION OF THE INVENTION

The chlorination process of this invention is not only unexpectedly efficient, but it also produces, directly, a CPVC composition which is distinguishable from prior art compositions. The efficiency of this process is attributable to a high concentration of chlorine molecules introduced as liquid directly into the interior of a PVC macrogranule, which itself provides a solid reaction medium in which the chlorination reaction can proceed in the presence of ultraviolet radiation, but without the presence of swelling agents or chlorohydrocarbon solvents. The process of this invention is peculiarly adapted to the chlorination of vinyl chloride homopolymer, because of the morphology of its macrogranules. However, it is also useful for the chlorination of solid mixtures of poly(vinyl chloride) homopolymer in conjunction with minor amounts of polymers of other monoolefinically unsaturated monomers. Preferred among such other monomers is polyethylene. The amount of polyethylene will vary depending upon the

characteristics of the particular polymer, but from about 5 parts to about 20 parts by weight of polyethylene per 100 parts of poly(vinyl chloride) is preferred, the polyethylene having a density in the range from about 0.92 to about 0.96 and a melt index in the range from about 0.3 to about 21 slashed zero

In the most preferred embodiment of this invention, it is used for chlorinating solid macrogranules of homopolymers of vinyl chloride, prepared by emulsion, suspension, solution or bulk polymerization techniques to yield a polymer having a relatively high molecular weight in the range from about 100,000 to about 1,000,000. In the process of this invention, the PVC starting material must have three essential chracteristics, namely, (1) a high molecular weight; (2) a macrogranular form; and (3) purity and freedom from contamination and degradation. These and other characteristics of the PVC starting material are disclosed in greater detail in U.S. Pat. No. 2,996,489 the disclosure of which is incorporated by reference herein as if fully set forth. The molecular weight of PVC may be related to its specific viscosity which is determined herein by dissolving 0.24 gram of the resin in 50 ml of nitrobenzene while mildly heating and agitating on a solution roller. The solutions are then filtered into an appropriate Ubbelohde viscometer, previously calibrated for the pure solvent. The flow times in seconds for the solutions are determined at four different dilutions to obtain flow data at a number of concentrations. A portion of the original filtered solution is dried to constant weight at 130 degree(s) C. to obtain a true concentration value. The ratio of the flow time of the solution to the flow time of the pure solvent is a value known as the "reduced viscosity." When the number (1) is substracted from "reduced viscosity," one obtains the value known as the "specific viscosity." The PVC starting material in the process of this invention has a high molecular weight such that it possesses a specific viscosity of at least 0.20. Where some other polymer, for example polyethylene is to be co-chlorinated with PVC homopolymer, it is preferred that the polyethylene have a specific viscosity of at least 0.20.

The chlorination process of this invention is carried out at a temperature below the condensation point of chlorine, as it is critical that the chlorine be absorbed within the macrogranules of PVC be present in the liquid state, under the pressure conditions of the reaction. It is more preferred that the temperature of reaction be substantially below the condensation point of chlorine at the pressure at which the reaction is to be carried out. This preferred temperature of reaction is in the range from about -50 degree(s) C. to about 50 degree(s) C., though a temperature as high as 70 degree(s) C. is operable. At atmospheric pressure this temperature of reaction is preferably in the range from about -50 degree(s) C. to about -40 degree(s) C., though lower temperatures as low as about -80 degree(s) C. may be employed. At 100 psig, the reaction temperature is about 25 degree(s) C., and even higher pressures and correspondingly high temperatures maybe used. However, above about 100 psig the benefits due to better diffusivity of liquid Cl sub 2 into the macrogranules of PVC and the particles of PE begin to be vitiated by the economic penalties of operating at the higher pressures.

Liquid chlorine is absorbed into macrogranules of PVC by spraying the liquid into a mass of granules which is being mildly agitated so as to present fresh macrogranule surfaces to the liquid which is quickly absorbed. By the term "absorbed" I refer to liquid chlorine held within a

macrogranule, irrespective of whether the precise mechanism of holding the chlorine entails absorption, adsorption, chemisorption or physiosorption. The amount of liquid chlorine sprayed on to the mass of PVC to be chlorinated is in the range from about 0.6 part to about 3 parts by weight chlorine per part by weight of PVC. In this range, and in the more preferred range of from about 0.75 to about 1.5 parts by weight liquid chlorine per part by weight of PVC, the mass appears to be relatively dry, and free-flowing. Calculations indicate that 1.13 parts by weight liquid chlorine per part of PVC is sufficient to yield, theoretically, a CPVC with a chemically bound chlorine content of 73.1%. The precise amount of chlorine actually introduced will depend upon the time of the reaction, the intensity of the ultraviolet radiation, and the physical and chemical characteristics of the PVC starting material. It will be evident that the physical and chemical characteristics of the CPVC product will vary accordingly, the desired product being obtained by routine and simple trial and error to stabilize all the variables.

No swelling agents are used in the process of this invention, so that only trapped hydrogen chloride (HCl) and liquid chlorine not consumed in the reaction are to be removed. Because the chlorination reaction is exothermic, the temperature of the reaction mass will tend to rise. Some chlorine may be evolved along with byproduct HCl, and evaporation of the chlorine tends to allow the reaction to proceed substantially isothermally. In general, additional cooling will be required to maintain the desired temperature of the mass of PVC macrogranules. Both HCl and evaporated chlorine are conveniently removed as gas, and chlorine may be condensed and recycled to the reaction, if desired, as is explained in greater detail herebelow.

Any form of actinic radiation is suitable; for example, ordinary incandescent lamps, mercury vapor or arc lamps, neon glow tubes , fluorescent tubes , carbon arcs and sodium vapor lamps may be employed. Ultra-violet light is the preferred source of illumination. In order to obtain a highly heatstable chlorinated resin when the chlorination is stimulated by photoillumination, the intensity of illumination is desirably controlled to avoid surges in temperature.

The CPVC product formed by the low liquid chlorine process of this invention is distinguishable from prior art CPVC not only by its spectral "fingerprint," but also by its physical characteristics, particularly its appearance. A visual examination of the CPVC product under 45X magnification shows that the majority of macrogranules appear milky white. These CPVC macrogranules are visually generally similar in size, shape and color to the PVC macrogranules from which they were derived. A more detailed comparison of the photomacrographs in FIGS. 3 and 4 clearly shows the similarity of the milky white opaque macrogranules. However, referring to FIG. 4, there is also seen a scattering of macrogranules which are not opaque and milky white, but glassy and translucent. With incident light used to make FIGS. 3 and 4, visual observation of the glassy particles in FIG. 4 indicates that many appear to be transparent. The presence of a substantial amount of these particles, more than about 15% by wt, results in lowered Izod impact strength, and lower elongation at break, in an experimental extrusion grade CPVC composition, so an amount greater than 15% by wt is to be avoided.

The surface area of the CPVC macrogranules is characteristically lower than that of the PVC macrogranules from which they were derived, the

decrease in surface area being in the range from about 10 to about 20 percent, depending upon the conditions of chlorination of the PVC. Surface area is measured by the BET method using nitrogen adsorption, as more fully described by Brunauer, Emmett and Teller in J.A.C.S. 60, 309-319, (1938).

When compared at the same weight percent chlorine, all CPVCs have essentially the same set of sup 13 C nmr chemical shifts. An easily observed feature of these spectra is the appearance of particular chemical shifts originating from sequences of unchlorinated PVC. Typically, a CPVC produced by the aqueous chlorination method, containing 65% by wt Cl sub 2 contains about 10-20% sequences of unchlorinated PVC. In contrast, CPVC prepared by the low liquid chlorination process of this invention, and also containing 65% by wt chlorine, contains about one-half the number of sequences of unchlorinated PVC, that is, in the range from about 3-5%. In addition, it can be shown that the CPVC prepared by the aqueous process contains a much different distribution of tacticities compared with that of CPVC prepared by the low liquid chlorine process.

Since the major portion of CPVC is produced for use in the piping industry, pipe grade CPVC contains at least 65% by wt Cl sub 2. However, there are some uses for CPVC where such high chlorine content (at least 65%) is not essential. For such uses, CPVC with a chlorine content in the range from about 59% to about 65% Cl sub 2 by wt, referred to as "lightly chlorinated PVC " is produced, which in combination with appropriate additives gives much improved properties. For example, flammability compares favorably with that of pipe grade CPVC . Lightly chlorinated PVC can be used not only to obtain better fire resistance than can be obtained with PVC, but also better thermal stability. Where such lightly chlorinated PVC is to be produced by the low liquid chlorine process of this invention, a much lower amount of liquid chlorine may be used than that required for pipe grade CPVC , particularly if the rate of reaction is not important. Thus, excellent lightly chlorinated PVC may be produced with as little as 0.1 part by wt of liquid Cl sub 2 per unit part by wt of PVC macrogranules, under generally the same temperature, pressure and photoillumination conditions as used to chlorinate with from about 0.6 to about 3 parts by wt of liquid Cl sub 2.

Referring now to FIG. 1, there is shown a flowsheet schematically illustrating a batch process of this invention. A jacketed reactor 10, suitably designed for operation at elevated temperature up to about 50 degree(s) C. and pressure up to about 100 psig, is equipped with a paddle stirrer, indicated generally by reference numeral 11, having a central shaft 12 and blades 13 designed to churn a mass of macrogranules of PVC (not shown) in the reactor, so that all macrogranules in the mass are uniformly irradiated by a bank of ultraviolet lamps 14 sealingly fitted into the cover 15 of the reactor. The cover is bolted to the reactor and tightly sealed for operation at the desired pressure, which preferably, is in the range from about 50 psig to about 100 psig. The cover is provided with a flanged nozzle (not shown) through which a jacketed condenser, indicated generally by reference numeral 20, is placed in open fluid communication with the interior of the reactor 10. The condenser 20 is fitted with inlet nozzle 21 and outlet nozzle 22 through which nozzles a cold heat transfer liquid (cryogen) is circulated at a temperature low enough to condense chlorine vapors evolved during the reaction, but not so low as to condense byproduct HCl gas which is also evolved. Liquid Cl sub 2

is charged to the reactor through feed line 16. Cl sub 2 vapor evolved during reaction is condensed and returned to the reactor being dripped upon the mass of macrogranules while they are being agitated. The cover 15 is also provided with a vent through which excess chlorine may be removed from the reactor. Optionally the cover may also be fitted with a nozzle through which an inert gas, such as nitrogen which does not enter into the chlorination reaction, may be fed to the reactor, either to assist in maintaining control of the temperature of the reaction, or to provide fluidization of the macrogranules to supplement the agitation provided by the stirrer 11.

Typically, the chlorination reaction is carried out batch-wise by charging a mass of macrogranules of PVC to the reactor, and commencing agitation to lower the temperature to about -0 degree(s) C. which is slightly higher than the temperature of the cooling fluid circulated through the reactor's jacket. A predetermined weight of liquid chlorine at about -0 degree(s) C. is then slowly sprayed onto the churning mass of PVC macrogranules until all the liquid chlorine is absorbed by the mass of PVC macrogranules. The ultraviolet lamps 14 are then switched on and agitation continued. No catalyst other than the u-v light is either desirable or necessary. The progress of the reaction may be monitored by noting the amount and rate at which HCl is evolved from the reaction zone of the reactor. When the reaction is essentially complete, as indicated by no further evolution of HCl, the agitation is stopped, and the CPVC formed is recovered. Runs at room temperature and corresponding pressure of about 100 psig are made in an analogous manner.

Referring now to FIG. 2, there is shown a flowsheet schematically illustrating a continuous process of this invention. A horizontal, elongated jacketed reactor 30 is equipped with a longitudinally axial helical agitator (referred to as a "votator") 31 with flights designed to lift macrogranules of PVC feed from near the bottom surface of the reactor to the top. The PVC feed is continuously flowed into the reactor from a PVC storage bin 40, by being metered through a vaned powder metering device 41 driven by an electric motor. The PVC feed enters near one end of the horizontal reactor 30. The lower portion of the reactor 30 is fitted with a chordal porous plate 32 which sections off the lower portion of the reactor immediately below the votator 31. The plate 32 serves to diffuse nitrogen gas uniformly along the length of the reactor. The nitrogen gas is introduced below the porous plate at several locations sith a manifold 33, thus serving to fluidize the macrogranules of PVC and also to maintain the temperature of the reaction zone within the reactor at about 0 degree(s) C., which is the temperature at which the nitrogen is introduced. The votator 31 is driven by an electric motor at a speed sufficient to churn the macrogranules exposing the surfaces of each to a liquid chlorine spray pumped into the reactor, near one end, through spray nozzles 35. The liquid chlorine is maintained at about 0 degree(s) C. in a storage tank 50 from which it is pumped to the nozzles. The liquid chlorine spray is soon absorbed by the churned macrogranules of PVC, which are moved longitudinally towards the other end of the reactor. In the mid-section of the reactor, which constitutes its reaction zone, there is provided above the votator 31, a bank of ultraviolet lights identified as "UV," which illuminate the liquid chlorine containing PVC macrogranules, and stimulate chlorination of the PVC to convert it to CPVC . As the chlorination reaction progresses, HCl gas is evolved, and because the reaction is

exothermic, sufficient heat is generated to evaporate some of the liquid chlorine absorbed in the PVC macrogranules. Though such evaporation of chlorine helps stabilize the temperature in the reaction zone, it is undesirable to permit so much chlorine to evaporate as will adversely affect the chlorination of the PVC. The amount of chlorine evaporated is controlled by maintaining a sufficiently low temperature in the reaction zone. This temperature is desirably controlled by controlling the temperature of the nitrogen gas being introduced to assist in the fluidization of the macrogranules.

Byproduct HCl gas, N sub 2 gas and chlorine vapors are removed from the reaction zone and flowed to a condenser 60 through which a cryogen is circulated to condense the chlorine, allowing only the HCl and N sub 2 to be recovered as gases. The condensed chlorine is desirably recycled to the spray nozzles. Nitrogen is separated from the HCl and recycled into the reactor, and the HCl is used in another process.

A mixture of macrogranules of PVC and particles of PE in a ratio in the range from about 95:5 to about 85:15 may also be chlorinated under substantially the same temperature and pressure conditions as those used for the low liquid chlorination of PVC alone. However, amounts of liquid chlorine less than 1.5 parts by wt per unit weight of PVC and PE mixture are wholly ineffective to produce an appreciable amount of CPVC . It appears that at levels below the 1.5:1.0 level, the liquid chlorine is predominantly absorbed by the PE particles with the result that so much PVC is left chlorinated, that, at first appraisal, any further attempts to co-chlorinate the polymers, would appear futile. Upon further addition of liquid chlorine, in an amount greater than 3 parts by wt per unit wt of PVC and PE mixture, it is found that a substantial amount of the PE particles are dissolved in the liquid Cl sub 2 resulting in a slurry-like mixture which is physically distinguishable by its flow characteristics from the unchlorinated mixture of solid polymers. Moreover, the product obtained upon co-chlorination of a mixture with greater than about 3 parts by wt of liquid Cl sub 2 per unit wt of solid polymer, does not have desirable physical properties for extrusion or injection molding of the co-chlorinated mixture.

Within the narrow range of from about 1.5 parts to about 3.0 parts by wt of liquid Cl sub 2 per unit wt of mixed unchlorinated resin, the mixture is wetted but free-flowing and has the appearance of being dry. The product formed by chlorinating such a wetted but free-flowing mixture is readily distinguishable from other mixtures such as are conventionally made by mixing CPVC and CPE, irrespective of the origin of either component. Applicant is unaware of any prior art chlorination of a mixture of PVC and PE, and particularly of any mixture of solid PVC and solid PE which produces discrete particles of CPVC to which are bound a cluster of CPE particles the majority of which CPE particles are discrete.

Measurement of the glass transition temperature (T sub g) at a particular chlorine level (%Cl sub 2) of the co-chlorinated mixture, an analysis of its sup 13 C nmr spectra, and evaluation of the results measured with a differential scanning calorimeter (DSC) indicate that the co-chlorinated product of this invention is distinguishable over prior art compositions. For example, the co-chlorinated mixture shows (a) a generally lower crystallinity than prior art resins as evidenced by lower heats of melting measured by DSC, and (b) sufficient crystallinity of the PE in the mixture to be evident in a thermal analysis curve. From a purely physical point of

view, a visual examination of Geon* 603X560 and DuPont LD-963 CPE mixed in a ratio of 90:10, is clearly a simple mixture demonstrating nothing more than occasional physical clumping of CPE particles occasionally upon a discrete CPVC macrogranule. In comparison, viewing the microphotograph of FIG. 6, it is apparent that clusters of CPE particles are bonded to macrogranules of CPVC . Though some clusters of CPE appear as agglomerates of many closely packed CPE particles, most CPVC macrogranules show clusters of discrete CPE particles on each macrogranule.

*Geon is a Trademark of The B. F. Goodrich Company

EXAMPLES

In a typical pilot plant run, 400 parts by wt of macrogranules of Geon*103EPF76 poly(vinyl chloride) resin, a general purpose resin, are charged to the jacketed reactor fitted with a helical paddle stirrer, and a bank of ultraviolet lights some or all of which may be turned on, as desired. Liquid cryogen such as a chilled brine solution, is circulated through the jacket of the reactor so as to keep the liquid chlorine in the liquid state at the pressure and temperature at which the chlorination reaction is to be carried out. After charging the reactor with PVC the reactor and its contents are subjected to vacuum, or flushed with an inert gas, preferably nitrogen. Thereafter, liquid chlorine is sprayed into the reactor while the macrogranules of PVC are being slowly churned by the paddle stirrer, until 500 parts of liquid Cl sub 2 are charged.

The reaction mass, though soaked with liquid Cl sub 2 appears to require substantially the same amount of mixing energy to churn it as was required prior to soaking. It is churned for a period of about 30 mins. This period is a "soak period" deemed critical to a successful utilization of this low liquid chlorine process. The duration of the soak period will vary depending upon the temperature and pressure at which the reaction is carried out, and may range from about 10 minutes to about 2 hours. This soak period is thought to allow time for the liquid Cl sub 2 to permeate the macrogranules so as to place themselves in effective positions within the PVC macrogranules to chlorinate them as desired. After the soak period, the bank of lights is turned on to irradiate the reaction mass substantially uniformly. The period of irradiation is in the range from about 4 to about 9 hours depending upon the particular physical characteristics of the PVC, and the intensity of the lights. A more preferred time for irradiation is in the range from about 5 to about 6 hours. While the mass is being irradiated, it is continuously slowly stirred to facilitate evolution of HCl and Cl sub 2 from the reaction mass, and to permit more uniform chlorination of the PVC. For economic reasons the preferred temperature of operation is in the range from about 0 degree(s) C. to about 35 degree(s) C., and the chlorine evolved is condensed and returned to the reactor for another run; the HCl evolved is recovered for use in another reaction. At the end of the reaction, the reactor is preferably again flushed with an inert gas, or subjected to vacuum stripping, to get rid of free chlorine and HCl still remaining. The chlorinated polymer (CPVC) is then recovered, and remaining traces of free chlorine and HCl are removed by drying the polymer.

The intensity of photo-illumination is not critical, and is chosen so as to obtain the desired conversion of PVC in a desirable period of time. It will also be recognized that the physical configuration of the reactor may impose certain limitations on the amount and intensity of actinic radiation

which may be provided.

In an analogous manner, a mixture of 400 parts by wt of macrogranules of Geon*103EPF76 poly(vinyl chloride) and 28 parts by wt of Microthene FA520 polyethylene (and others) are co-chlorinated in the pilot plant reactor.

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Several other runs are made in a laboratory reactor, Table I setting forth the conditions under which PVC is chlorinated, and Table II setting forth the conditions under which a mixture of PVC and PE is co-chlorinated, and in each case stating the results obtained. The surface area of the PVC starting material in Table I, measured by the BET method, is in the range from about 1.25 to about 1.75 m sup 2 /g, and the surface area of the CPVC obtained is less than 1.0 m sup 2 /g, the decrease in surface area being characteristically in the range from about 20 to about 50%. The surface areas of the mixtures of PVC and PE starting material used in the examples set forth in Table II are likewise greater than the surface area of the co-chlorinated mixture obtained, though the decrease generally obtained was not measured.

I claim:

1. A process for chlorinating a mass of freely flowable solid, discrete, poly(vinyl chloride) macrogranules, comprising, contacting said mass with from about 0.1 part to about 3 parts by weight of liquid chlorine per part by weight of said mass, at a temperature in the range from about -50 degree(s) C. to about 50 degree(s) C.; absorbing said liquid chlorine in said poly(vinyl chloride) macrogranules to produce liquid chlorine-containing macrogranules; agitating said liquid chlorine-containing macrogranules to maintain a reaction zone in which said mass is a free-flowing mass; irradiating said free-flowing mass of liquid chlorine-containing macrogranules with actinic radiation for a period of time sufficient for a reaction of said liquid chlorine in a solid medium, which reaction chemically bonds at least 59% by weight of chlorine with said poly(vinyl chloride) which is thus converted to chlorinated poly(vinyl chloride); removing hydrogen chloride from said reaction zone; and, recovering a free-flowing mass of macrogranules of said chlorinated poly(vinyl chloride).

2. The process of claim 1 wherein said macrogranular particles of said poly(vinyl chloride) polymer have an average diameter in the range from about 10 microns to about 500 microns, and a porosity in the range from about 0.2 to about 0.3.

3. The process of claim 2 wherein said macrogranular particles of said poly(vinyl chloride) individually consist essentially of a mass of primary particles of said polymer having an average diameter in the range from about 0.05 microns to about 5.0 microns.

4. The process of claim 3 wherein said microgranules of chlorinated poly(vinyl chloride) have substantially the same size and shape, but lower surface area than said macrogranules of poly(vinyl chloride) from which the former were derived.

5. The process of claim 4 wherein agitating said mass includes introducing an inert gas into said reaction zone.

6. The process of claim 4 wherein agitating said mass includes mechanically agitating it in said reaction zone.

7. The process of claim 4 including removing gaseous chlorine from said reaction zone, condensing said gaseous chlorine, and returning liquid

poly(vinyl chloride) macrogranules, comprising, contacting said mass with from about 0.1 part to about 3 parts by weight of liquid chlorine per part by weight of said mass, at a temperature in the range from about -50 degree(s) C. to about 50 degree(s) C.; absorbing said liquid chlorine in said poly(vinyl chloride) macrogranules to produce liquid chlorine-containing macrogranules; agitating said liquid chlorine-containing macrogranules to maintain a reaction zone in which said mass is a free-flowing mass; irradiating said free-flowing mass of liquid chlorine-containing macrogranules with actinic radiation for a period of time sufficient for a reaction of said liquid chlorine in a solid medium, which reaction chemically bonds at least 59% by weight of chlorine with said poly(vinyl chloride) which is thus converted to chlorinated poly(vinyl chloride); removing hydrogen chloride from said reaction zone; and, recovering a free-flowing mass of macrogranules of said chlorinated poly(vinyl chloride) in the form of macrogranules having a size range from about 50 to about 500 microns, and from about 5 to about 15% by weight of said macrogranules, when magnified, have the appearance of being translucent, the remaining being milky and opaque.

19. A chlorinated poly(vinyl chloride) and chlorinated polyethylene composition comprising a product obtained by chlorinating a mass of freely flowable solid, discrete, poly(vinyl chloride) macrogranules intermingled with solid, discrete particles of polyethylene comprising, contacting said mass with from about 1 part to about 3 parts by weight of liquid chlorine per part by weight of said mass, at a temperature in the range from about -50 degree(s) C. to about 50 degree(s) C.; absorbing said liquid chlorine in said poly(vinyl chloride) macrogranules to produce liquid chlorine-containing PVC macrogranules, and adsorbing said liquid chlorine on said polyethylene to produce liquid chlorine-coated PE particles; agitating said liquid chlorine-containing PVC macrogranules and said liquid chlorine-coated PE particles to maintain a reaction zone in which said mass is a free-flowing mass; irradiating said free-flowing mass with actinic radiation for a period of time sufficient to react a predetermined amount of chlorine with (a) with said poly(vinyl chloride) which is thus converted to chlorinated poly(vinyl chloride) by reaction of said liquid chlorine in a solid medium, and (b) with said polyethylene which is thus converted to chlorinated polyethylene; removing hydrogen chloride from said reaction zone; and, recovering a free-flowing mass of macrogranules of said chlorinated poly(vinyl chloride), and particles of chlorinated polyethylene, said macrogranules being in the form of macrogranules having a size range from about 50 to about 500 microns, and from about 5 to about 15% by weight of said macrogranules, when magnified, have the appearance of being translucent, the remaining being milky and opaque, and the majority of said macrogranules having a cluster of discrete particles of said chlorinated polyethylene bonded thereto.

20. The product of claim 19 wherein from about 30% to about 60% by weight of the chlorinated polyethylene occurring in runs of 9 or more carbon atoms is unchlorinated, and the chlorinated runs contain from about 50% to about 60% by weight chlorine.

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RIGID CHLORINATED POLYVINYL CHLORIDE COMPOUND AND ARTICLES DERIVED THEREFROM

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U.S. CLASS: 524-180 cross ref: 525-84; 525-86
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FIELD OF SEARCH: 524-180; 525-84; 525-86

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ABSTRACT

CPVC compositions, pipe, and a method of preparing a pipe are disclosed and comprise CPVC having 63% to 70% by weight chlorine and preferably 65% to about 69% chlorine; a high rubber impact modifier comprising a graft copolymer of a rubbery polydiene and one or preferably more than one hardening monomer selected from a group consisting of a vinyl aromatic monomer, a (meth)acrylate, and a (meth)acrylonitrile monomer

including mixtures. Said graft copolymer exhibits a Shore D hardness of less than about 64, and preferably between about 35 and 45; and a chlorinated polyethylene containing between 30% and 40% chlorine by weight, compression molded placques derived from the powder composition exhibit a minimum tensile strength, modulus, izod impact strength, Tg and dynamic thermal stability specified herein. A pipe extruded directly from said composition meets ASTM-D2846 and exhibits unexpected ductility down to 20 degree(s) F. (-6.6 degree(s) C.) under fixed drop dart impact testing. The invention is useful for example in articles such as hot and cold water distribution system components installed in seasonal environments.

FIELD OF THE INVENTION

The present invention relates to improved thermoplastic articles exhibiting an improved combination of properties. In particular, post-chlorinated polyvinyl chloride compounds are disclosed which exhibit as extrudate, a particular balance of strength, heat deflection temperature, low temperature ductility and stress rupture properties. As extruded profiles the compounds meet specified cell classification requirements under ASTM-D2846 for CPVC rigid thermoplastic compounds.

BACKGROUND OF THE INVENTION

Post chlorinated polyvinyl chloride (CPVC) excels in higher heat deflection temperature (HDT) compared to polyvinyl chloride and is a starting material for thermoplastic compounds for hot water pipes, and particularly pressure pipes, waste gas pipes, ducts, storage tanks, construction materials among other uses.

CPVC , in order to perform adequately for the intended use is generally formulated with impact modifiers, and flow enhancing additives among other ingredients to arrive at a balance of properties. Each additive chosen for one particular advantage often is accompanied by a corresponding undesired effect on another property. Antagonistic relationships have been observed between the following additives and properties impact modifiers

	vs	melt flow rate
"	vs	heat deflection temperature
"	vs	tensile modulus
"	vs	dynamic thermal stability
"	vs	weathering

flow enhancers

	vs	tensile modulus
"	vs	low temperature brittleness
"	vs	tensile strength
"	vs	heat deflection temperature

Various attempts to overcome the observed limitations to modifications of CPVC are evident in the art. U.S. Pat. No. 3,299,182 discloses a blend of halogenated polyolefin and CPVC , in particular, chlorinated substantially linear polyethylene (CPE). The preferred CPE contains about 30% to 40% by weight chlorine, and is present at from about 2 to less than 10 parts by weight per 100 weight parts of CPVC (pbw), and preferably 5 to 8 parts. It has been observed that blends of CPE with CPVC do not meet the requirements of ASTM-D1784 under cell classification 2-3-4-4-7. The minimum requirements for meeting cell classification 2-3-4-4-7 under ASTM-D1784 for

a CPVC composition are a notched izod impact strength of at least 1.5 ft multiplication dot lbf per inch notch (80.1 J/m of notch), a tensile strength of at least 7,000 psi (48.25 MPa), a modulus of elasticity of at least 360,000 psi (2,481 MPa), a heat deflection temperature (HDT) under a 264 psi (1.82 MPa) load of at least 100 degree(s) C. Specifically, CPE alone in combination with CPVC fails to meet tensile modulus and, izod impact per ASTM-D1784, long term hydrostatic design strength per ASTM-D2846, and a desired low temperature ductility.

U.S. Pat. No. 3,453,347 discloses impact strength improved CPVC on addition of amorphous rubbery polymerized alkylene monoepoxides and CPE. The particular oxirane monomers found to produce a rubbery amorphous polymer contain at least 3 consecutive carbons, for example butene-1-oxide. CPE is present at from 5 to about 10 parts and the polyepoxide is present at from about 0.25 parts to about 2.5 parts per hundred weight parts CPVC . The inherent viscosity of the parent PVC from which the chlorinated PVC is derived has a preferred level of greater than about 0.55. The blends disclosed are powder mixed and ready for injection molding.

CPVC powder compound which is in use today is required for high output extrusion processes. Higher output pounds per hour are attained with powder compound and under certain expertly operated, larger extrusion machines, output per hour has exceeded 900 lbs./hr. This narrower processing window places a high demand on a powder extrusion compound in terms of processibility. In the short amount of residence time and under high temperature and controlled shear, a powder compound must achieve complete fusion and resist decomposition in contact with surface temperatures which could otherwise break-down CPVC in a matter of minutes, rendering the fabricated article unsalable.

A high strength blend of CPVC and a styrene-acrylonitrile (SAN) copolymer is disclosed in U.S. Pat. No. 4,647,646. The blend exhibits preferably a single homogenous phase wherein the preferred embodiment consists essentially of CPVC having between 60.5% and 64.5% chlorine and styrene-co-acrylonitrile (SAN) containing between 18% and 24% acrylonitrile. The blend exhibits improved tensile strength, however a particularly high tensile strength in the absence of improved impact resistance and in particular, an absence of low temperature ductility is not useful for hot and cold water distribution system (HCWD) components such as plumbing pipes and fittings or in drain-waste-vent systems. A combination of properties is required. Upon impact modification of this blend, a loss in HDT and modulus is predicted.

An improved melt processible CPVC composition is disclosed in U.S. Pat. No. 4,584,349 ('349) comprising a CPVC polymer having chlorine content of between about 60% and 66% in combination with polymethylmethacrylate (PMMA). The blends exhibit a substantially single phase morphology and the glass transition temperature (Tg) of the blends was higher than the Tg for the CPVC and PMMA separately. Tg for amorphous polymers is highly correlated with HDT. In some applications, achieving a HDT higher than CPVC is desirable. Higher Tg and improved melt flow are achieved in '349, however compositions with high HDT and melt flow alone are not entirely acceptable for HCWD uses without additional properties, particularly, tensile strength, modulus, impact properties and low temperature properties. Attempts to balance all of the desired properties particularly for powder extrusion processing are met with sacrifices in at least one property such as HDT or tensile strength when pursuing improvements in

another property. There is considerable art and less science demonstrated both for formulating a composition and in processing that composition to develop all required properties for improved HCWD compounds.

U.S. Pat. No. 4,710,533 ('533) discloses CPVC blends comprising a combination of a flow enhancing amount of alpha-methyl styrene polymers and/or alpha-methyl styrene-co-acrylonitrile, an impact modifier of ABS or MBS, lead stabilizer(s), acrylic processing aid and lubricant(s). The blends exhibit good thermal stability, impact strength and melt viscosity, however an HDT of no higher than 91.5 degree(s) C. is achieved. HDT is a critical property for HCWD uses, however a minimum value of 100 degree(s) C. is required for cell class 2-3-4-4-7. In addition, unacceptable low temperature impact performance and tensile modulus for the compositions of '533 would be expected. Addition of impact modifier might improve somewhat the impact strength but would not correct the deficiency in HDT.

Accordingly, it would be desirable to obtain a CPVC composition which meets cell class 2-3-4-4-7 higher, and a pipe derived therefrom exhibiting a minimum 180 degree(s) F. (82.2 degree(s) C.) hydrostatic design stress of 500 psi (3.5 MPa) or higher per ASTM-D2846 and has improved low temperature ductility. Such a composition and article derived therefrom which exhibits this desired combination of properties not been heretofore disclosed and represents a long felt need in the art pertaining to HCWD components. With regard to this balance of properties it would be preferable, moreover a practical necessity, for achieving this combination in an extruded or molded article directly from a powder compound. The compound must also exhibit adequate dynamic thermal stability for use in commercial extrusion and injection molding processes.

SUMMARY OF THE INVENTION

It is therefore one aspect of the present invention to provide a thermoplastic composition preferably in powder form, and comprising a specified major proportion of CPVC , a specified minor proportion of impact modifier, a flow enhancing component along with specified minor amounts of stabilizer(s), lubricant(s) and other optional additives, wherein said composition exhibits a specified performane level in several properties simultaneously in the fused state and heretofore unachieved.

It is a specific aspect of the present invention to provide a composition, preferably in particulate form comprising a major proportion of CPVC specified herein, a minor proportion of a graft copolymer comprising a rubbery polydiene polymer and one or more hardening monomers, said hardening monomers are selected from the group consisting of vinyl aromatic monomers, (meth)acrylate monomers, (meth)acrylonitrile monomers and mixtures thereof; and a chlorinated polyolefin specified herein. Said composition, in a fused state, exhibits a combination of properties wherein CPVC is the continuous phase. Said combination in a fused state exhibits a tensile strength minimum value, a minimum tensile modulus, a minimum heat deflection temperature, a minimum izod impact strenth, low temperature ductility and dynamic thermal stability.

A 3/4 inch (19 mm) standard dimension ratio 11 (SDR-11), copper tube size (cts) pipe extruded directly from a powder composition exhibited an unexpected ductility during low temperature drop impact testing and exceeded the minimum long term hydrostatic stress rupture requirement of ASTM-D2846. The term parts used throughout this specification refers to

parts by weight per 100 parts by weight CPVC .

These aspects are obtained by the composition of the present invention comprising CPVC having a specified chlorine content and derived from a PVC resin having a specified Inherent Viscosity range (I.V.) in combination with from about 1 to about 5 pbw of a chlorinated polyethylene specified hereinbelow, from about 5 to about 15 weight parts of an impact modifier selected from at least one of the group consisting of an ABS graft copolymer having a Shore D hardness generally less than about 64 and preferably in a range between about 35 and 45 and non-ABS graft copolymer having a Shore D hardness between 35 and less than 42. The composition further comprises from 0 to about 20 pbw combined of one or more components selected from the group consisting of lubricants, processing aids, pigments, colorants, stabilizers, co-stabilizers, and plasticizer, and flame retardants.

DETAILED DESCRIPTION OF THE INVENTION

CPVC referred to in this specification means chlorinated polyvinyl chloride having a specified weight percent (wt %) of chlorine between about 63% and about 70%, and preferably between about 65% and 69%. Where the chlorine content is outside of the specified range, CPVC exhibits characteristics which render it unsuitable in the present invention. Above the maximum specified chlorine level, the compositions derived therefrom would exhibit inadequate processing properties, poor impact properties and inadequate dynamic thermal stability for the intended use.

There are considerations pertaining to the precursor PVC polymer from which is derived the post chlorinated PVC employed in this invention. The molecular weight of PVC as indicated by inherent viscosity measurement per ASTM-D1243 generally can range from about 0.2 to about 2.0 at the extremes. Preferably, the I.V. of precursor PVC employed falls within a range of from about 0.4 to about 1.6 with the most preferred range of 0.7 to about 1.2. In the examples below the CPVC employed was derived from a precursor homo-PVC having an I.V. of about 0.9.

CPVC is known to the art and to the literature and is commercially available. The preferred polymerization method for preparing the precursor PVC is the aqueous suspension method. Details of this method are beyond the scope of this invention and need not be disclosed as suspension PVC processes are the predominant method used in the art. CPVC can be made according to any commercial chlorination process or the like such as by a solution process, a fluidized bed process, a preferred water slurry process, a thermal process, or a liquid chlorine process. Inasmuch as chlorination processes for preparing CPVC resins are established and CPVC is readily available in the art, they will not be discussed in great detail herein. Rather, reference is hereby made to the several CPVC patents set forth in the background art, e.g. U.S. Pat. Nos. 2,996,049; 3,100,762; etc., which are hereby fully incorporated by reference with regard to the preparation of CPVC .

The CPVC resins utilized in the present invention generally have a density of from about 1.45 to about 1.67 grams/cc at 25 degree(s) C. and a preferred glass transition temperature (Tg) between about 110 degree(s) C. and about 150 degree(s) C., as measured by a differential scanning calorimeter (DSC). Tg is recorded generally as the midpoint or inflection point of the DSC curve in the temperature range at which the material undergoes the transition from the glassy state. The most preferred CPVC

resin has a density in the range of from about 1.51 to about 1.58 grams/cc at 25 degree(s) C. and a glass transition temperature between about 120 degree(s) C. and 140 degree(s) C.

CPVC referred to in this specification is generally derived from a PVC homopolymer. CPVC , also within the purview of the present invention may be derived from a PVC copolymer having up to 5 parts of comonomer per 100 parts by weight of vinyl chloride monomer. For example, vinyl chloride can advantageously be polymerized in the presence of a chain terminating coreactant such as a solvent, an ethylenic unsaturated alkylene such as an alpha olefin or a reactive mercaptan such as 2-mercapto ethanol. Where the preursor PVC contains less than about 5 parts total of one or more comonomers per 100 parts of vinyl chloride, this polymer is described in the term of art as a homopolymer. Therefore the CPVC derived therefrom carries the same meaning in the term of art context.

According to the present invention, CPVC can be blended with or contain generally small amounts of PVC and/or PVC copolymers. The amount of PVC homopolymer or copolymer can be up to about 25 percent by weight, desirably up to about 10 percent by weight, and preferably nonexistent based upon 100 parts by weight of CPVC .

Copolymers of vinyl chloride and comonomer(s) are known to the art and can be post-chlorinated. The vinyl chloride copolymer may contain up to about 30 parts of comonomer based upon 100 weight parts of the vinyl chloride, and preferably less than about 20 parts of comonomer. The copolymer can comprise a minor amount of a third monomer. Copolymers include vinyl chloride copolymerized with esters of (meth)acrylic acid wherein the ester portion has from 1 to 12 carbon atoms, for example, methyl acrylate, ethyl acrylate, butyl acrylate, octyl acrylate, cyanoethyl acrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate, and the like; vinyl (C sub 2 -C sub 8) esters, for example vinyl acetate, -propionate, -butyrate and the like; acrylonitrile, and methacrylonitrile; styrene derivatives having a total of from 8 to 15 carbon atoms such as alpha-methylstyrene, vinyl toluene, chlorostyrene; vinyl naphthalene; diolefins having a total of from 4 to 8 carbon atoms such as isoprene, and including halogenated olefins such as chlorobutadiene; monoolefins having from 2 to 10 carbon atoms such as ethylene, propylene, and butylene, with isobutylene being preferred. The preferred CPVC is derived from homopolymer PVC.

It is further contemplated in the present invention that CPVC can be blended with a CPVC copolymer. The amount of the CPVC copolymer can be up to about 30 parts per 100 weight parts of a CPVC homopolymer, and is preferably absent.

The high rubber graft copolymers referred to in this specification are graft copolymers prepared by graft-polymerizing less than about 50 wt % of at least one rigid monomer such as a vinyl aromatic monomer, an acrylic monomer, a vinyl nitrile monomer or a mixture thereof in the presence of more than about 50 wt % of a pre-formed rubbery polydiene substrate such as a 1,3-diene polymer or copolymer thereof. In particular, the graft copolymers comprise from 50 to 90 wt % of a rubbery substrate polydiene such as for example polybutadiene or polyisoprene, or a copolymer of a 1,3-diene with less than about 50 wt % of a copolymerizable vinyl or vinylidene monomer such as for example an olefin, a styrene monomer, a (meth)acrylate ester monomer, or a (meth)acrylonitrile monomer, and from 10 to 50 wt % of a rigid graft phase formed from at least one rigid vinylidene

or vinyl monomer selected from the group consisting of vinyl aromatic monomers, (meth)acrylic monomers, vinyl nitrile monomers and mixtures thereof. A rigid monomer is a hardening monomer and for the purposes of this invention means a polymerizable vinyl or vinylidene monomer that when homopolymerized would exhibit a glass transition temperature greater than 20 degree(s) C. The term rubbery substrate or rubbery copolymer means, as is conventionally recognized, a polymer having a rubbery or elastomeric character including a glass transition temperature generally below 0 degree(s) C. and preferredly below about -70 degree(s) C. The rubbery polymer can contain a polydiene which is partially hydrogenated.

In the preparation of high rubber graft copolymers, either or both the rubbery or the rigid graft component may further include minor amounts, less than about 5 wt %, of a copolymerizable crossinking monomer(s) such as a di-or tri-functional monomer or combination to increase graft linking and/or cross-linking of either or both components. Preferably, crosslinking monomer(s) are absent. The high rubber graft copolymers may be prepared by any of the variety of conventional polymerization processes including emulsion, suspension, sequential emulsion-suspension, bulk and solution polymerization processes. These methods are known in the polymerization art specifically directed toward the preparation of a wide variety of high rubber graft copolymers for impact modification of thermoplastic resins. Suitable specific embodiments of the particular impact modifiers can be prepared by any of the aforementioned polymerization means. The preferred polymerization processes are in aqueous media and include emulsion and suspension methods. The preferred process for preparing the rubbery portion is by way of emulsion polymerization as taught in the art.

An exemplary high rubber graft copolymer composition includes the class of high rubber ABS graft copolymer resins, which may generally be described as graft copolymers of styrene and acrylonitrile on butadiene containing rubbers. Other high rubber graft copolymers include non-ABS polydiene rubber containing graft copolymers including methylmethacrylate-styrene-acrylonitrile grafted on polybutadiene or styrene-butadiene rubbers (MABS resins), and graft copolymers of methylmethacrylate and styrene grafted on polybutadiene or styrene-butadiene rubbers (MBS resins).

It has been observed that only specific high rubber graft copolymers are suitable in this invention within the wide variety available in the art. Moreover with the use of these specific types, the desired combination of properties can only be achieved by utilizing the chosen impact modifier in an amount within a specific range. The particular high rubber graft copolymer found to impart unexpected ductility behavior under low temperature fixed drop dart impact testing is a high rubber ABS graft copolymer (most preferred) having a Shore D hardness less than about 64, preferably less than 50 and most preferably in a range between about 35 and 45 and a non-ABS polydiene rubber containing graft copolymer, preferably a MBS type having a Shore D hardness of from 35 to less than 42. The specific range of amount in terms of parts by weight (pbw) of said suitable high rubber graft copolymer employed in the CPVC composition can range from about 5 pbw to about 15 pbw and interdepends in part, on the particular CPVC chosen. A high I.V. PVC which is chlorinated to a level at the bottom of the specified range herein may enable achieving the desired combination of properties at the lower end of the specified impact modifier amount. Conversely, a lower I.V. PVC which is chlorinated to a level at the high

end of the specified range may require a correspondingly higher amount of high rubber impact modifier within the range herein specified. In the preferred practice of employing the preferred CPVC in which the I.V. of the precursor PVC ranges from about 0.7 to about 1.2 and wherein the chlorine level is between about 67 wt % to about 69% chlorine, the preferred amount of said impact modifier present can vary from about 5 pbw to about 10 pbw. The teachings herein are sufficient for the practioner to reduce the invention to practice in a reasonable trial and error approach employing variations in amounts as well as the choice of component characteristics within the specified ranges for those characteristics.

The postchlorinated polyethylene (CPE) for use in the blends of this invention is a rubbery material resulting from the chlorination of a polyethylene having a substantially linear structure, a density (ASTM-D1505-57T) of from about 0.91 to about 0.98 gram/cc. at 25 degree(s) C., a melting point usually in the range of from about 100 degree(s) C. to 130 degree(s) C.; and a melt index (according to ASTM-D1238-57T) in the range above about 0.05, more preferably in the range from about 0.05 to about 20. A good method of preparing such a CPE material is more fully described in U.S. Pat. No. 3,299,182. Suitable embodiments are commercially available.

CPE materials generally contain from about 5% to about 50% wt. of combined chlorine, however those containing from about 30% to about 40% wt. of combined chlorine, and most preferably from about 32% to about 38% chlorine, are suitable for use in the present invention. In the examples herinbelow, a CPE containing about 36% chlorine was employed. The amount of CPE present can range from about 1 pbw to about 10 pbw, and is dependant in part on the particular CPVC chosen relative to the aforementioned molecular weight and chlorine levels. Within the preferred range of CPVC characteristics discussed, it is preferred to utilize CPE at from about 1 pbw to about 5 pbw, and most preferably between 1 and 3 pbw.

It is expected that other components may be advantageously included in the compounds of the present invention. When employed, these can include compounds from the group consisting of lubricants, stabilizers, tinting colorants, plasticizers, blueing agents, pigments, Tg enhancing additive(s) and processing aids all of which are established compounding ingredients and serve various purposes known in the PVC compounding art. Exemplary lubricants are polyglycerols of di- and trioleates, polyolefins such as polyethylene, polypropylene and oxidized polyolefin and high molecular weight paraffin. In the examples 2.2 parts of polyethylene and oxidized polyolefin were used. Preferred are mixtures of C sub 2 polyolefin and oxidate and are employed at levels generally ranging from about 1 part to about 3 parts combined. Exemplary heat stabilizing ingredients employable herewith are referred to in the art as alkyltin compounds such as methyltin, butyltin, octyltin, mixed metal alkyltins, dialkyl tin di-carboxylates, methyltin mercaptides, butyltin mercaptides used in the examples at 2.4 parts, octyltin mercaptides, dialkyl tin bis(alkylmercaptocarboxylate) including di-n-octyltin-S,S'-bis(isooctyl mercaptoacetate), butylthiostannoic acid, and other ester tins. Di-lower alkyl tin stabilizers such as C sub 4 to C sub 8 alkyl tin mercaptides are preferred. Stabilizer(s) are generally present at from about 0.05 pbw to about 3 pbw.

Exemplary processing aids are acrylic polymers such as poly methylacrylate. Other processing aids are disclosed in The Plastics and

Rubber Institute: International Conference on PVC Processing, Apr. 26-28 (1983), Paper No. 17. Processing aids are preferably absent.

Exemplary pigments such as calcium carbonate, carbon black, talc, clay, mica, and preferably titanium dioxide can be included. Titanium dioxide was used at 5 pbw in the examples below. Pigment is present if at all generally at from about 0.5 parts to about 20 parts, and preferably from about 0.5 parts to about 6 parts.

Specific examples of plasticizers include derivatives of carboxylic acid esters including the various derivatives of adipic acid, azelaic acid, phthalic acid, benzoic acid, and citric acid, isobutyric acid, isophthalic acid derivatives, sebacic acid derivatives, isosebacic acid derivatives, stearic acid, tartaric acid, oleic acid, succinic acid; phosphoric acid derivatives, derivatives of terephthalates, pentaerythritol, trimellitic acid, and mixtures. Other plasticizers can be included for example, partial esters of the above carboxylic acids, ethers, glycol derivatives, glycolates, glycerol derivatives, are set forth in The Technology of Plasticizers, by Sears and Darby, pages 893-1085, John Wiley & Sons, New York, 1982, which is hereby fully incorporated by reference. Plasticizers are preferredly absent.

Optional exemplary Tg enhancing additives include SAN polymers, PMMA, the polyimides such as polyglutarimide, polymaleimide, polyitaconimide, and are commercially available. Examples of the preparation of certain polyimides are described by Kopchik, U.S. Pat. No. 4,246,374, and Schroder, et al. U.S. Pat. No. 3,284,425. The polyimides include imide methacrylate copolymers and/or polyaliphatic imide copolymers. The polyimide copolymers are manufactured and sold by the Rohm and Haas Company under the trade names of Paraloid(r) HT-510, Paraloid(r) EXL-4151, Paraloid(r) EXL-4171, Paraloid(r) EXL-4241 and Paraloid(r) EXL-4261. Tg enhancing additives are preferably absent.

The components are generally combined and mixed with powder mixing equipment such as a Henschel mixer, or ribbon blender and can be cubed or preferably left in powder form. Alternatively less than all of the components can be combined first, with the remaining component(s) combined in a multiple screw extruder. The powder composition of the present invention is generally processed in conventional extrusion machinery such as a twin screw extruder or a single screw extruder or other processing means including injection molding for example of pipe coupling components among the myriad useful articles. The thermoplastic powder compositions are processed at conventional melt temperatures from about 175 degree(s) C. to about 235 degree(s) C., and preferably from about 200 degree(s) C. to about 225 degree(s) C. for CPVC .

An extruder generally has a conveying means such as a hopper through which the material is charged, an intermediate screw processing portion, and a final die through which the material is discharged in the form of an extrudate. It is further advantageous to use low friction sizing such as gauging discs or vacuum sizing sleeves. The multi-screw extruder is widely used for extrusion of pipe. There are two types of multi-screw extruders: counter-rotating screws and co-rotating screws. Conical twin screw, four screw and parallel twin screws in use are preferably counter-rotating multi-screw extruders. They are generally gravity or meter fed. The co-rotating screws can be used as compounding machines and sometimes for extrusion of pipe. In most cases, output rates are dependent upon the extruder size, drive power and screw design. The machine characteristics

applicable to melt process the composition of the present invention include:
Head pressure rating of at least 7500 psi (51.7 MPa).
Extruder drive/gearbox capable of generating high torque at low rpm.
Vacuum venting to remove volatiles, moisture and entrapped air.
A barrel L/D of at least 16/1.
Temperature controllers able to control within 5 degree(s) F. or better.
Accurately controllable powder metering screw.

EXAMPLES

The following standard testing methods referred to here apply to the distinguished properties of the subject inventionProperty
Standard

Tensile Strength ASTM-D638
Tensile Modulus ASTM-D638
Notched Izod Impact ASTM-D256
Heat Deflection Temp. ASTM-D648
Drop Impact Strength ASTM-D2444
Hydrostatic Strength ASTM-D1598
Inherent Viscosity ASTM-D1243
Shore Hardness ASTM-D530
Specific Gravity ASTM-D792

The compositions in the examples were also evaluated for processing stability. A primary commercial measure of the relative thermal stability and processability of CPVC compounds is the "dynamic thermal stability" (DTS) test. This test is designed to measure the time-torque relationship at selected temperatures using an instrument such as the Brabender Plasti-corder. The test value generally reported, and used for comparison, is the "DTS time". DTS time is usually defined as the time required for the instrument torque to fall to its minimum value, with the polymer compound in the melted state, before beginning to increase, presumably due to instability and usually accompanied by autogenous cross-linking. DTS time is dependent not only on polymer properties, but also on temperature, sample size, stabilizers, lubricants, instrument operating conditions, degree of instrument maintenance, and other conditions which are controlled for accurate comparison between different compounds. A DTS time of lower than about 16 minutes is generally undesirable and preferably DTS time is equal to or higher than about 18 minutes. Where temperature is not specified below, the temperature is presumed to be room temperature.

EXAMPLE 1

Nine parts of ABS graft copolymer with a Shore D hardness of 44 were combined in a powder mixer with one hundred parts of CPVC containing 68.5% chlorine, and pigment, stabilizer and lubricants outlined above. The composition was fused on a two roll mill, and compression molded into plaques. The compression molded plaques were tested for heat deflection temperature, tensile strength, tensile modulus, and izod impact strength. The heat deflection temperature was 101 degree(s) C., tensile strength was 7,745 psi (53.39 MPa), the tensile modulus was 342,200 psi (2,359 MPa and the izod impact was 9.5 ft multiplication dot lbf per inch notch (507.1 J/m of notch). The powder composition was conveyed to a CM 55 conical twin

screw extruder and extruded into a 3/4 inch (19 mm) SDR-11 cts tubing (ASTM-D2846) and tested for fixed energy drop impact at several temperatures to observe the presence of ductility. In particular, drop impact was measured at 40 degree(s) F. (4.4 degree(s) C.), 30 degree(s) F. (-1.1 degree(s) C.), and 20 degree(s) F. (-6.6 degree(s) C.). Long term hydrostatic stress rupture (LTHS) testing was also conducted. LTHS testing was conducted for each example over a period of between about 190 hours and about 600 hours at 180 degree(s) F. (82.2 degree(s) C.) to predict the 100,000 hour intercept value. This value is the estimated tensile stress in the wall of a pipe in the circumferential orientation that when applied continuously will cause failure of the pipe at 100,000 hours. The minimum LTHS at 180 degree(s) F. (82.2 degree(s) C.) required under ASTM-D2846 is 1000 psi (7.0 MPa). The hydrostatic design stress is LTHS multiplied by a safety factor of 0.5. Therefore a test pipe exhibiting a LTHS of 1000 psi (7.0 MPa) has a hydrostatic design stress of 500 psi (3.5 MPa). Percent scatter was also reported. Under ASTM-D2846 there is a maximum specified reliability which is expressed as percent scatter, and under this specification a scatter of 15% is the maximum acceptable. An extruded 3/4 inch (19 mm) SDR-11 cts tubing derived from the composition of Example 1 exhibited a drop impact 43.9 ft multiplication dot lbf (59.5 N-m). At 40 degree(s) F. (4.4 degree(s) C.) and 12 ft multiplication dot lbs. (16.25 N-m) of energy, there were 10 passes in 10 trial and at 15 ft multiplication dot lbs.(20.32 N-m), 10 passes in 10 trials. At 30 degree(s) F. (-1.1 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) of energy, the ductility was 10 passes in 10 trials and at 15 ft multiplication dot lbs.(20.32 N-m), 10 passes in 10 trials. At 20 degree(s) F. (-6.6 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m), there were 9 passes out of 10 trials and at 15 ft multiplication dot lbs.(20.32 N-m) 4 passes out of 10 trials. The 100,000 hr. intercept LTHS was 1,279 psi (8.817 MPa) and a percent scatter of 5.9 percent. The powder composition of Example 1 exhibited a Brabender DTS of 16 minutes. This composition does not meet all of the requirements for ASTM-D1784, in particular, the tensile modulus minimum.

EXAMPLE 2

One hundred parts of CPVC of Example 1 was combined in a powder mixer with seven parts of an ABS impact modifier of Example 1, pigment, lubricant and stabilizer as in the previous example. The powder composition was fused on a two roll mill, and compression molded. Compression molded plaques of Example 2 exhibited a heat deflection temperature of 100 degree(s) C., tensile strength of 8,088 psi (5.575 MPa), a tensile modulus of 390,800 psi (2,694 MPa) and an izod impact of 5.4 ft multiplication dot lbf per inch notch (288.2 J/m of notch). The powder composition was extruded into a pipe as in the previous example and exhibited a drop impact of 34.9 ft multiplication dot lbs.(47.3 N-m). The ductility at 40 degree(s) F. (4.4 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) of energy was 10 passes in 10 trials, and at 15 ft multiplication dot lbs.(20.32 N-m) there were 9 passes in 10 trials. At 30 degree(s) F. (-1.1 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) of energy, there were 6 passes in 10 trials and at 15 ft multiplication dot lbs.(20.32 N-m) there were 8 passes in 10 trials. At 20 degree(s) F. (-6.6 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) of energy, there were 4 passes in 10 trials and at 15 ft multiplication dot lbs.(20.32 N-m) there were no passes in 10 trials. The 100,000 hr. intercept LTHS was 1,365 psi (94.10 MPa) and

a percent scatter of 4.5 percent. The powder composition of Example 2 exhibited a Brabender of DTS of 21 minutes, and meets the requirements of ASTM-D1784, however this composition exhibited poor processing characteristics and is not suitable for extrusion of pipe.

EXAMPLE 3

One hundred parts of the CPVC of Example 1 was combined in a powder mixer with nine parts of a chlorinated polyethylene outlined above, pigment, lubricant and stabilizer as in the previous examples. The powder composition was fused on a two roll mill and pressed into plaques as in the previous examples. Fused press plaques of Example 3 exhibited a heat deflection temperature of 100 degree(s) C., a tensile strength of 7,956 psi (54.84 MPa), a tensile modulus of 346,000 psi (2,385 MPa) and an izod impact of 1.9 ft multiplication dot lbf per inch notch (101.4 J/m of notch). The powder composition was extruded as in the previous example into a pipe and tested for drop impact, which was 21.1 ft multiplication dot lbs. (28. 6 N-m). The pipe exhibited a ductility at 40 degree(s) F. (4.4 degree(s) C.) and 12 ft multiplication dot lbs. (16.25 N-m) of energy in 4 passes out of 10 trials and at 15 ft multiplication dot lbs. (20.32 N-m) there were 4 passes out of 10 trials. At 30 degree(s) F. (-1.1 degree(s) C.) and 12 ft multiplication dot lbs. (16.25 N-m) of energy, there were no passes in 10 trials and at 15 ft multiplication dot lbs. (20.32 N-m) there waere no passes in 10 trials. There were no passes at 20 degree(s) F. (-6.6 degree(s) C.). The 100,000 hr. intercept LTHS was 161 psi (1.109 MPa) and the percent scatter was 17.4 percent. The powder composition of Example 3 exhibited a Brabender DTS of 24 minutes, and the cts tubing derived does not meet the requirements of ASTM-2846.

EXAMPLE 4

One hundred parts of CPVC as in previous Examples were combined in a powder mixer with two parts of chlorinated polyethylene, pigment, lubricant and stabilizer as in the previous examples. The powder composition was fused on a two roll mill and compression molded into plaques for testing of the following properties. The fused composition of Example 4 exhibited a heat deflection temperature of 101 degree(s) C., a tensile strength of 8678 psi (59.82 MPa), and a tensile modulus of 393,000 psi (2,709 MPa). The izod impact was 0.7 ft multiplication dot lbf per inch notch (37.36 J/m of notch). The powder composition of Example 4 was extruded into a pipe as before for testing of the following properties. The drop impact value was 5 ft multiplication dot lbs. (6.7 N-m) and the ductility at 40 degree(s) F. (4.4 degree(s) C.) and 12 ft multiplication dot lbs. (16.25 N-m) was 0 passes in 10 trials and 0 passes in 10 trials at 15 ft multiplication dot lbs. (20.32 N-m). There were no drop impact passes for the pipe derived in Example 4 at 30 degree(s) F. (-1.1 degree(s) C.) nor at 20 degree(s) F. (-6.6 degree(s) C.). The 100,000 hr. intercept long term hydrostatic strength was 535 psi (3.688 MPa) and scatter of 17.1 percent. The powder composition of Example 4 exhibited a Brabender dynamic thermal stability 27 minutes, however a 3/4 inch (19 mm) SDR-11 cts tubing derived therefrom fails to meet the requirements of ASTM-D2846.

EXAMPLE 5

Two parts of the chlorinated polyethylene were combined in a powder mixer with one hundred parts CPVC as in the previous Examples and included 7 parts of a methacrylate butadiene styrene (MBS) impact modifier having a Shore D hardness of 42, pigment, lubricant and stabilizer as the previous example. The composition was fused on a two roll mill and compression

molded into plaques for testing of the following properties. Fused plaques of the composition of Example 5 exhibited a heat deflection temperature of 99 degree(s) C., a tensile strength of 8,089 psi (55.76 MPa), a tensile modulus of 360,600 psi (2,485 MPa), and an izod impact of 7.7 ft multiplication dot lbf per inch notch (411 J/m of notch). The powder composition of Example 5 was fed into an extruder, extruder, into an SDR-11 pipe as before and tested for the following properties. The extruded pipe exhibited a drop impact of 39.7 ft multiplication dot lbs. (53.7 N-m). At 40 degree(s) F. (4.4 degree(s) C.) and a energy of 12 ft multiplication dot lbs. (16.25 N-m) the pipe exhibited a fixed drop impact ductility of 9 passes in 10 trials and at 15 ft multiplication dot lbs. (20.32 N-m) energy it exhibited a ductility of 10 passes in 10 trials. There were at 30 degree(s) F. (-1.1 degree(s) C.) and 12 ft multiplication dot lbs. (16.25 N-m) 10 passes in 10 trails and at 15 ft multiplication dot lbs. (20.32 N-m) of energy the ductility was also 10 passes in 10 trials. At 20 degree(s) F. (-6.6 degree(s) C.) and a energy of 12 ft multiplication dot lbs. (16.25 N-m) the ductility was 7 passes in 10 trials and at 15 ft multiplication dot lbs. (20.32 N-m) of energy the ductility was 0 passes in 10 trials. The 100,000 hr. intercept long term hydrostatic strength for the pipe derived from the composition of Example 5 was 1,170 psi (8.06 MPa) and a percent scatter of 4.9 percent. The powder composition of Example 5 exhibited a Brabender dynamic thermal stability of 22.6 minutes, and did not meet the minimum HDT requirements of ASTM-D2846.

EXAMPLE 6

Composition of Example 6 contained a combination of the CPVC used in Example 1 combined in a powder mixer with two parts of a chlorinated polyethylene, seven parts of an ABS impact modifier having a Shore D hardness of 64, pigment, lubricant, and stabilizer as in the previous examples with mixing until a uniform composition was achieved. The composition was fused on a two roll mill and compression molded for testing for the properties below. The fused, pressed plaques of Example 6 exhibited a heat deflection temperature of 100 degree(s) C., a tensile strength of 8,352 psi (57.57 MPa), a tensile modulus of 450,300 psi (3,104 MPa), and an izod impact strength of 2.0 ft multiplication dot lbf per inch notch (106.7 J/m of notch). The powder composition of Example 6 was fed to an extruder and extruded into pipe wherein the pipe was tested for drop impact, low temperature fixed drop impact failure, and long term hydrostatic strength. An extruded pipe derived from Example 6 composition exhibited a drop impact of 36.0 ft multiplication dot lbs.(48.7 N-m) and a ductility at 40 degree(s) F. (4.4 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) of 6 ductile passes in 10 trials, and at 15 ft multiplication dot lbs.(20.32 N-m) at 40 degree(s) F. (4.4 degree(s) C.) 5 passes in 10 trials. At 30 degree(s) F. (-1.1 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) the pipe exhibited 6 passes in 10 trials, and at 15 ft multiplication dot lbs.(20.32 N-m) 2 passes in 10 trails. At 20 degree(s) F. (-6.6 degree(s) C.) and a energy of 12 ft multiplication dot lbs.(16.25 N-m) the pipe of composition 6 exhibited 1 pass in 10 trials and at 15 ft multiplication dot lbs.(20.32 N-m) the pipe did not pass in any incidents in 10 trials. The 100,000 hr. intercept long term hydrostatic stress rupture value obtained from the pipe of Example 6 was 1,306 psi (9.003 MPa) and a 10.4 percent scatter. The powder composition of Example 6 exhibited a marginal Brabender dynamic thermal stability time of 16 minutes, meets the requirements of ASTM-D1784 for cell class 2-3-4-4-7.

EXAMPLE 7

In this example 100 parts of a CPVC as in the previous examples were combined in a powder mixer with two parts of a chlorinated polyethylene outlined above, and seven parts of the high rubber ABS graft copolymer of Example 1, pigment, lubricant and stabilizer as in the previous examples until a uniformed dry powder composition was obtained. The compression molded composition of this example exhibited a heat deflection temperature of 101 degree(s) C., a tensile strength of 7,997 psi (55.13 MPa), a tensile modulus of 363,500 psi (2,505 MPa), and izod impact strength of 7.7 ft multiplication dot lbf per inch notch (411 J/m of notch). Extruded pipe of the composition exhibited a drop impact of 41 ft multiplication dot lbs (55.5 N-m) and exhibited a ductility at 12 ft multiplication dot lbs.(16.25 N-m) and 40 degree(s) F. (4.4 degree(s) C.) of 9 passes in 10 trials, and at 15 ft multiplication dot lbs.(20.32 N-m) and 40 degree(s) F. (4.4 degree(s) C.), 8 passes in 10 trials. At 30 degree(s) F. (-1.1 degree(s) C.) and 12 ft-lbs. (16.25 N-m) there were 9 passes out of 10 trials, and at 15 ft multiplication dot lbs.(20.32 N-m) there were 7 passes out of 10 trials. At 20 degree(s) F. (-6.6 degree(s) C.) and 12 ft multiplication dot lbs.(16.25 N-m) there were 9 passes in 10 trials and at 15 ft multiplication dot lbs.(20.32 N-m) there were 3 in 10 trials. The 100,000 hr. intercept long term hydrostatic stress rupture was rated at 1,242 psi (8.562 MPa) and a percent scatter of 11.2 percent. The powder compound exhibited a Brabender dynamic thermal stability of 18 minutes. In a fused state the composition of Example 7 passes the performance requirement of ASTM-D1784 for cell class 2-4-4-4-7, and exhibited satisfactory ductility under fixed drop dart impact testing at 20 degree(s) F. (-6.6 degree(s) C.).

It is noted from the following examples by comparison that the compositions of Examples 1, 2, 5, 6, and 7 exhibit desired properties, i.e. heat deflection temperature, tensile strength, modulus, izod impact strength, and drop impact strength. Example 1 fails under ASTM-D1784, has inadequate DTS, and is not processible for extruding pipe. Example 2 passes ASTM-D1784. but has inadequate 20 degree(s) F. fixed drop impact ductility and unacceptable processibility properties. Example 5 did not pass the requirements of ASTM-D1784 and did not exhibit adequate low temperature ductility. Example 6 has marginal processibility, meets the requirements under ASTM-D1784 cell class 2-3-4-4-7 and exhibits ductility at 20 degree(s) F. (-6.6 degree(s) C.) but somewhat less than the most preferred embodiment in example 7. The composition of Example 7 is processible, meets ASTM-D2846, and develops as an extrudate, derived directly from a powder composition, acceptable 20 degree(s) F. (-6.6 degree(s) C.) fixed drop impact ductility and is the best mode of the invention as directed specifically to a molded article.

Various changes and modifications may be made in carrying out the present without departing from the spirit and scope thereof. These changes are to be considered as part of the invention. While in accordance with the Patent Statutes, the best mode and preferred embodiment has been set forth. The scope of the invention is not limited thereto, but rather by the scope of the attached claims.

What is claimed is:

1. A composition, comprising: chlorinated polyvinyl chloride containing

from about 63% by weight to about 70% by weight chlorine, said chlorinated polyvinyl chloride polymer is derived from a polyvinyl chloride polymer having an inherent viscosity between about 0.4 and about 1.6, from about 5 to about 15 weight parts per 100 weight parts of chlorinated polyvinyl chloride, a graft copolymer containing more than 50 weight percent of a polydiene and one or more hardening monomers, said graft copolymer selected from at least one of the group consisting of a ABS graft copolymer having a Shore D hardness of from 35 to less than 64, and a non-ABS polydiene containing graft copolymer having a Shore D hardness of from 35 to less than 42; from about 1 to about 5 weight parts per 100 weight parts of chlorinated polyvinyl chloride of a chlorinated polyethylene containing from about 5% to about 50% by weight chlorine, and a stabilizer for said chlorinated polyvinyl chloride.

2. The composition of claim 1 wherein said graft copolymer contains a graft polymer of a polydiene rubber and hardening monomer(s) selected from the group consisting of vinyl aromatic, (meth)acrylate, (meth)acrylonitrile and mixtures.

3. The composition of claim 1 wherein said graft copolymer is derived from a 1,3-diene polymer or copolymer, a vinyl aromatic monomer and a (meth)acrylonitrile monomer, said graft copolymer having a Shore D hardness between about 35 and about 45.

4. The composition of claim 1 wherein said graft copolymer is a MBS graft polymer having a Shore D hardness from about 35 to less than 42.

5. The composition of claim 1 wherein said polyvinyl chloride polymer has an inherent viscosity of from about 0.7 to about 1.2 and said chlorinated polyvinyl chloride contains from about 65% to about 69% by weight chlorine.

6. The composition of claim 5 wherein said at least one stabilizer is a tin stabilizer.

7. The composition of claim 3 wherein said graft copolymer is present at from about 5 to about 10 parts by weight per 100 weight parts of chlorinated polyvinyl chloride.

8. The composition of claim 7 wherein said chlorinated polyethylene is present at from about 1 to about 3 pbw.

9. The composition of claim 8 in a fused state which meets or exceeds the minimum requirements of ASTM-D2846 and exhibits ductility under fixed drop dart impact testing at 20 degree(s) F. (-6.6 degree(s) C.) and at least 12 ft multiplication dot lbf (16.25 N-m).

10. The composition of claim 6 further comprising a pigment, a polyolefin and oxidized, wherein a compression molded plaque of said composition exhibits a tensile strength of at least 7,000 psi (4.825 MPa), a modulus of elasticity of at least 360,000 psi (2,481 MPa), an izod impact strength greater than about 1.5 ft multiplication dot lbf per inch notch (80.1 J/m of notch) per inch of notch.

11. The composition of claim 10 exhibiting a notched Izod impact of at least 5.0 ft multiplication dot lbf per inch notch (266.9 J/m of notch).

CHLORINATED POLYVINYL CHLORIDE RIGID PIPE AND METHOD OF FORMING SUCH PIPE

PATENT NO.: 5,591,497
ISSUED: January 07, 1997 (19970107)
INVENTOR(s): Hartitz, Joachim E., Avon Lake, OH (Ohio), US (United States of America)
ASSIGNEE(s): The B F Goodrich Company, (A U.S. Company or Corporation), Akron, OH (Ohio), US (United States of America [Assignee Code(s): 35360]
APPL. NO.: 8-603,496
FILED: February 20, 1996 (19960220)

This is a continuation of application Ser. No. 07-923,108, filed Aug. 31, 1992, now abandoned, which is a division of application Ser. No. 656,538, filed Feb. 15, 1991, now U.S. Pat. No. 5,194,471.

U.S. CLASS: 428-36.92 cross ref: 138-177; 428-36.9
INTL CLASS: [6] F16L 9-12
FIELD OF SEARCH: 138-177; 138-D7; 428-35.7; 428-36.8; 428-36.9; 428-36.92; 524-180; 525-84; 525-86
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PRIMARY EXAMINER: Nakarani, D. S.
CLAIMS: 21
EXEMPLARY CLAIM: 1
ART UNIT: 136

ABSTRACT

CPVC compositions, pipe, and a method of preparing a pipe are disclosed and comprise CPVC having 63% to 70% by weight chlorine and preferably 65% to about 69% chlorine; a high rubber impact modifier comprising a graft copolymer of a rubbery polydiene and one or preferably more than one hardening monomer selected from a group consisting of a vinyl aromatic monomer, a (meth)acrylate, and a (meth)acrylonitrile monomer including mixtures. Said graft copolymer exhibits a Shore D hardness of less than about 64, and preferably between about 35 and 45; and a chlorinated polyethylene containing between 30% and 40% chlorine by weight, compression molded placques derived from the powder composition exhibit a minimum tensile strength, modulus, izod impact strength, Tg and dynamic thermal stability specified herein. A pipe extruded directly from said composition meets ASTM-D2846 and exhibits unexpected ductility down to 20 degree(s) F. (-6.6 degree(s) C.) under fixed drop dart impact testing. The invention is useful for example in articles such as hot and cold water distribution system components installed in seasonal environments.

What is claimed is:

1. An extruded pipe, comprising: 100 weight parts of chlorinated polyvinyl chloride derived from a polyvinyl chloride polymer having an inherent viscosity of between about 0.4 and 1.6, said chlorinated polyvinyl chloride containing from about 63% to about 70% by weight chlorine, from about 5 to about 15 weight parts of a copolymer of a polydiene and one or more hardening monomers, said copolymer selected from of the groups consisting of an ABS copolymer and an non-ABS polydiene containing copolymer further comprising at least one incorporated comonomer selected from the group consisting of a vinyl aromatic, a methacrylate, an acrylate, methacrylonitrile, acrylonitrile, and mixtures thereof, from about 1 to about 10 weight parts of chlorinated polyethylene, a pigment, a stabilizer and a lubricant, wherein said pipe exhibits ductility under fixed drop dart impact at 20 degree(s) F. (-6.6 degree(s) C.) of at least 12 ft solid dot lbf (16.25 N-m), and a hydrostatic design stress greater than about 500 psi (3.5 Mpa) at 180 degree(s) F.

2. The extruded pipe of claim 1 wherein said stabilizer is a tin stabilizer.

3. The extruded pipe of claim 1 wherein said CPVC contains from about 65% to about 69% by weight chlorine.

4. The extruded pipe of claim 1 wherein said at least one copolymer is a graft copolymer of a 1,3-diene polymer or copolymer, and hardening monomer(s) selected from the group consisting of a vinyl aromatic monomer, a (meth)acrylate monomer, a (meth)acrylonitrile monomer, and mixtures thereof.

5. The extruded pipe of claim 4 wherein said copolymer is an ABS graft copolymer having a

Shore D hardness between about 35 and 45.
6. The pipe of claim 1 wherein said inherent viscosity of said polyvinyl chloride polymer ranges from about 0.7 to about 1.2 and contains from about 67% to about 69% by weight chlorine.
7. The pipe of claim 1 wherein said non-ABS copolymer is a methacrylate-butadiene-styrene copolymer.
8. The pipe of claim 1 wherein said chlorinated polyethylene contains from 30% to 40% by weight chlorine.
9. The pipe of claim 8 wherein said chlorinated polyethylene is present at from about 1 to about 5 weight parts per 100 weight parts of chlorinated polyvinyl chloride.
10. The pipe of claim 9 wherein said chlorinated polyethylene is present at from about 1 to about 3 weight parts per 100 weight parts of chlorinated polyvinyl chloride.
11. The pipe of claim 8 wherein said chlorinated polyethylene contains from 32% and 38% chlorine by weight.
12. The pipe of claim 1 wherein said copolymer is present at from about 5 to about 10 weight parts per 100 weight parts of chlorinated polyvinyl chloride.
13. An extruded chlorinated polyvinyl chloride pipe derived from a composition comprising chlorinated polyvinyl chloride having 65% to 69% by weight chlorine, a copolymer impact modifier comprising polybutadiene and having a Shore D hardness of from about 35 to less than about 64, chlorinated polyethylene, a stabilizer, an acrylic process aid and titanium dioxide, wherein said composition compression molded into a plaque exhibits a notched izod impact strength of at least 1.5 lb solid dot lbf per inch notch (80.1 J/m of notch), a tensile strength of at least 7,000 psi (48.25 MPa), a modulus of elasticity of at least 360,000 psi (2,481 MPa), and a heat deflection temperature (HDT) under a 264 psi (1.82 MPa) load of at least 100 degree(s) C., wherein said extruded pipe exhibits a 100,000 hr. intercept long term hydrostatic stress rupture of at least 1,000 psi (7.0 MPa) and a percent scatter of less than 15% percent, and wherein said pipe exhibits ductility under fixed drop dart impact testing at 20 degree(s) F. (-6.6 degree(s) C.) of at least 12 ft solid dot lbf (16.25 N-m).14. The chlorinated polyvinyl chloride pipe of claim 13 exhibiting ductility under fixed drop dart impact testing at 20 degree(s) F. (-6.6 degree(s) C.) of at least 15 ft solid dot lbf (20.32 N-m).15. The chlorinated polyvinyl chloride pipe of claim 14 wherein said compression molded plaque exhibits a notched Izod impact of at least 5.0 ft solid dot lbf per inch notch (266.9 J/m of notch).16. An extruded pipe, consisting essentially of: (a) chlorinated polyvinyl chloride derived from a polyvinyl chloride polymer having an inherent viscosity of from 0.7 to about 1.2, said chlorinated polyvinyl chloride containing from about 67% to about 70% by weight chlorine, (b) an impact modifier comprising polydiene and at least one other incorporated monomer selected from the group consisting of a vinyl aromatic monomer, a (meth)acrylate monomer and a (meth)acrylonitrile monomer, wherein said impact modifier has a Shore D hardness of from 35 to less than 64 and said impact modifier is present at from about 5 to about 15 weight parts per 100 weight parts chlorinated polyvinyl chloride, (c) a stabilizer,
(d) a pigment, and
(e) at least one lubricant, wherein said pipe exhibits ductility under fixed drop dart impact at 20 degree(s) F. (-6.6 degree(s) C.) and at least 12 ft solid dot lbf (16.25 N-m) and a hydrostatic design stress greater than about 500 psi (3.5 Mpa) at 180 degree(s) F.
17. The extruded pipe of claim 16, wherein said impact modifier is present at from about 5 to about 10 weight parts per 100 weight parts chlorinated polyvinyl chloride.

18. The extruded pipe of claim 16 wherein the chlorinated polyvinyl chloride is blended with up to about 25 parts by weight of polyvinyl chloride per 100 parts by weight of chlorinated polyvinyl chloride.

19. The extruded pipe of claim 16 wherein said chlorinated polyvinyl chloride has an inherent viscosity of about 0.9 and said impact modifier has a Shore D hardness of about 44.

20. The extruded pipe of claim 16 wherein said at least one lubricant is selected from the group consisting of polyglycerol, polyolefin, oxidized polyolefin, and paraffin.

21. An extruded thermoplastic pipe comprising chlorinated polyvinyl chloride containing from about 63 wt. % to about 70 wt % chlorine exhibiting ductility under fixed drop dart impact at 20 degree(s) F. (-6.6 degree(s) C.) and at least 12 ft solid dot lbf (16.25 N-m) and a hydrostatic design stress greater than about 500 psi (3.5 Mpa) at 180 degree(s) F.

US PAT.FULL. (DIALOG« File 654): (c) format only 1997 Knight-Ridder Info. All rights reserved.

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT C

Excerpts from BF Goodrich "Flowguard Gold" FG-2G re: Cold Weather Considerations and Chemical Compatibility of FlowGuard Gold CPVC Products

Cold Weather Considerations

While the toughness of FlowGuard Gold pipe compared to other CPVC pipe is remarkably greater, we still recommend some additional precautions in cold weather situations.

Handling

- Refrain from unneccesary abuse. Do not drop pipe from trucks, drag pipe on the ground, step on pipe, or drop pipe on the ends.
- Inspect pipe ends for hairline cracks before making a joint.
- Store pipe in a heated area whenever possible.

Solvent Cement

- Use the same precautions to protect CPVC solvent cement from freezing as you would with PVC cement.
- Once cement gels, it can not be recovered and should be discarded.

Testing

- Cold temperature increases the necessary cure times prior to pressure testing a solvent welded system.
- If overnight temperatures are likely to drop below 32° F, drain the system. CPVC may split like copper when water freezes in it.
- Anti-freeze solutions can be used for pressurized testing provided that they are glycerine-based and approved for use in potable water application. GLYCOL type anti-freezes attack CPVC and *should not be used.*

Dealing with Frozen CPVC lines

Immediately take action to eliminate the source of cold air causing the freeze condition. Then thaw water line, if possible. When thawing a frozen CPVC water line, it is important to remember to LIMIT THE HEAT SOURCE TO 180° F OR LESS.

If the frozen section of pipe is accessible, heated air can be blown directly onto the freeze area by using a low wattage heater/blower. A second option is to apply electrical heat tapes to the problem area.

FLOWGUARD GOLD CPVC

September 27, 1995
(Superceedes June 29, 1995)

Chemical Compatibility of FlowGuard Gold CPVC Products

CPVC domestic water systems have been used successfully for more than 35 years in new construction, repipe and repair. CPVC products are ideally suited for domestic water applications due to their outstanding corrosion resistance. Occasionally, however, CPVC and PVC can be damaged by contact with chemicals found in some construction products (and site preparations). Reasonable care needs to be taken to insure that products coming into contact with FlowGuard Gold CPVC systems are chemically compatible. BF Goodrich recommends that chemical compatibility with CPVC be confirmed with the manufacturer of the product in contact with CPVC piping systems.

The following products have been shown to be UNACCEPTABLE for (unprotected use) contact with FlowGuard Gold CPVC systems. Chemically incompatible products are added to this list as they are brought to our attention. A product's absence from this list does not imply or insure CPVC chemical compatibility. ALWAYS CHECK THE PRODUCT MANUFACTURERS' RECOMMENDATION IN THIS REGARD.

Unacceptable Products
Do Not Use With FlowGuard Gold

Thread Sealants

Company	Sealant
General Sealant	GS-600
Guardian	High Performance Teflon Thread Sealing Compound
Cajon Company	SWAK
Harvey's	Pipe Thread Compound TFE Paste Thread Sealant
Jomar	"Tuffer than Tuf" Tef Seal
IPS, Inc	IPS Seal-On 500
Permatex Company, Inc	Permatex 14H

BFGoodrich
BFGoodrich Specialty Chemicals
9911 Brecksville Road
Cleveland, Ohio 44141-3247
216-447-5000 • 800-321-1144

Unacceptable Products
Do Not Use With FlowGuard Gold

Thread Sealants (con't)

Company	Sealant
SOS Products Company	Teflon Pipe Dope
Rectorseal Corporation	Rectorseal #5 Rectorseal #21
JC Whitlam Mfg Co.	TU Type 555 Seal Unyte Thread Hard Set Blue Magic Industrial Grade
Jet Lube, Inc.	Jet Lube TFW
Oatey	Pipe Joint Compound* Pipe Joint Compound - Teflon*
Devcon	Super Lock Hi-Strength Stud Lock Grade 2271
Hercules	Brush on/Blue Block
LA-CO Industries, Inc.	Slic Tite
Locktite	Removable Thread Sealer 242
National Starch & Chemical	Permalok LH050
Penna-Lok	Pipe Sealant

Note. BF Goodrich recommends teflon tape as the preferred thread sealant for FlowGuard Gold CPVC systems.

* Note: Oatey Pipe Joint Compound & Oatey Pipe Joint Compound with Teflon should not be confused with Oatey Great White Pipe Joint Compound.

Unacceptable Products
Do Not Use With FlowGuard Gold

Fire Stopping Systems

Company	System
Proset	Proseal Plug
Flame Stop	Flame Stop V
3M	Fire Barrier CP 25N/s No-Sag Caulk
Fyre-Sil	Silicone Sealant
X-Femo	Fyre-Sil Silicone Sealant

Leak Detector

Company	Product
Federal Process Co.	Gasoila Leak-Tech

Pipe Sleeve

Company	Product
Southern Metal & Plastic Products	.027 pipe sleeve

Pipe Insulation

Company	Product
Imcoa	ImcoaShield (intended for refrigeration)

Foam-in-Place Sealants

Company	Product
Red Devil	Class I Expanding Foam Sealant
Touch & Seal	High Yield Foam Sealant

Unacceptable Products
Do Not Use With FlowGuard Gold

Pipe Tape

Company	Product
Pak, Inc.	Pipe wrap tape

Pro

Insecticide

Company	Product
Dow Chemical	Dursban

Misc Materials

Company	Product
-	Roofing Tar
	Edible Oils (i.e., Crisco, Mazola)
	Lubricant
WD 40N	Silicone Lubricants Victaulic
-	Victaulic
Victaulic	
Lubricant	

Note:
BF Goodrich also publishes a more complete listing covering application of individual compounds. This may be found in the BF Goodrich Chemical Resistance Chart for CPVC Piping Products. The user is also encouraged to compare data from the individual product's MSDS to the published Chemical Resistance Chart.

D

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT D

USEPA letter to Unibell PVC Pipe Association re: vinyl chloride contamination of a Kansas public water supply, April 1, 1993

APR 0 5 1993

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

APR 1 1993

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 3
To Jim Rash	From Dave Eckstein
Co.	Co.
Dept.	Phone #
Fax #	Fax #

Mr. Dave Eckstein
Uni-Bell PVC Pipe Association
2655 Villa Creek Drive
Suite 155
Dallas, Texas 75234

Dear Mr. Eckstein:

This letter is a follow-up to our phone conversation of March 22, 1993, in which we discussed scheduling a conference call on possible solutions to the vinyl chloride contamination of a Kansas public water supply. As I mentioned in our phone conversation, a conference call has been scheduled between yourself, Dr. James Goodrich of EPA-Cincinnati, Mr. Dave Waldo of Kansas Department of Health and Environment, Ralph Flourney, Chief of the EPA Region VII Public Water Supply Section, and myself, the Kansas Coordinator in the EPA Region VII Public Water Supply Section. The conference call is scheduled for April 8 from 9:00 to 10:00 A.M. CST. The phone number to call for the conference call is (202) 260-3832.

I have enclosed a narrative summary of the information we have on the vinyl chloride contamination of the public water supply system. If you have any questions about the information in the summary, please call me at (913) 551-7440. We look forward to your assistance with this contamination problem.

Sincerely,

Elizabeth Murtagh Yaw

Elizabeth Murtagh Yaw
Kansas PWS Program Coordinator
State Programs Section

Enclosure

VINYL CHLORIDE CONTAMINATION OF DONIPHAN CO. RWD #5, KANSAS

KDHE detected vinyl chloride in the distribution system of Doniphan Co. RWD #5 at concentrations between less than 1 ppb to 8.9 ppb in June 1992. Doniphan Co. RWD #5 purchases water from Wathena, KS, who has not had vinyl chloride detected in its water. This fact, along with the fact that no other VOCs were detected in the distribution system, led to suspicions that the vinyl chloride may be leaching from the PVC pipe in the distribution system. The PVC pipe in the distribution system is fairly old, with about 40% of it installed in 1968, 40% in the early 1970's, and the remainder in the mid-1970's. Repairs to the system were made in the early 1980's with PVC pipe that is not certified for drinking water use.

Following up on the situation, KDHE conducted sampling of six or seven other rural water districts in Kansas constructed about the same time as Doniphan Co. RWD #5 with PVC pipe. Three samples were taken from each of the other rural water districts sampled. A couple of the rural water districts had vinyl chloride at concentrations above 1 ppb in one sample. KDHE resampled those rural water districts with detections of vinyl chloride above 1 ppb, but did not find significant concentrations of vinyl chloride in any other water supply.

In September 1992, KDHE conducted additional sampling at Doniphan Co. RWD #5. Nine samples were collected at different locations in the distribution system. Results ranged from 2.9 to 7.4 µg/l vinyl chloride. KDHE conducted tests on sections of PVC pipe from the water district that were cut out in making repairs to the system. Three sections of PVC pipe were filled with water containing 1 mg/l free chlorine and allowed to stand undisturbed for 10 days. The results showed that 11.1, 7.8, and 7.2 µg/l were measured in the three sections of pipe after 10 days. The tests were also conducted on sections of PVC pipe from the water district after being filled with distilled water containing no chlorine and allowed to stand for 10 days. Upon analysis, the distilled water from all three sections of pipe contained between 5 and 15 ppb vinyl chloride.

In December 1992, KDHE sent sections of PVC pipe from the rural water district to the National Sanitation Foundation (NSF) for analysis. The NSF has a standard procedure for checking PVC pipe for vinyl chloride monomer, which might leach into the water, before certifying it for potable water use. NSF conducted the tests on pipe sections from Doniphan Co. RWD #5 and found much higher concentrations of vinyl chloride monomer in the pipe than is allowed in pipe certified by NSF for potable water use. NSF sent KDHE a written report, with more specific information on the tests run and results found. We have requested a copy of the

NSF report. KDHE believes they have collected enough samples from different areas of the distribution system to conclude that the vinyl chloride appears to be leaching from the oldest 70 - 80% of the distribution system, that is, the pipe that was installed in the late 60's and early 70's.

KDHE provided public notice of the vinyl chloride contamination to the rural water district's customers in July 1992. People were advised to use an alternate source of water for drinking. EPA has written KDHE requiring that public notice be provided again, and continue quarterly, as long as the violation continues.

E

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT E

European Council of Vinyl Manufacturers website: www.pvc.org, "Question and Answer Page"

Q Recent reports suggest that plasticisers used in PVC disrupt the human hormone system and can reduce sperm counts. Surely we cannot accept such a risk?

A Concerns have been raised that a wide range of chemicals, including some plasticisers, might cause reproductive effects on man and wildlife by mimicking the natural sex hormone oestrogen. This hypothesis is based on some very inconclusive data and much published research also contradicts it. Many everyday substances, such as soya and dairy products, also contain natural oestrogens which are significantly more powerful than man-made oestrogen-like substances.

Nevertheless, the European chemical industry, as a whole, takes the possibility of a general effect extremely seriously and has comm-issioned detailed research. This is being co-ordinated through CEFIC - the European Chemical Industry Council.

Q Do you already have any proof that the plasticiser used in PVC does not cause reproductive health problems?

A PVC is made flexible by using many different types of plasticisers. The most commonly used plasticisers have already been found not to be oestrogenic. Some less common plasticisers appear to have weak oestrogenic activities. However, even these data are inconclusive and further work is underway.

Q Why is lead used as a stabiliser? Isn't lead a poisonous material?

A Lead is an abundant, naturally-occurring metal

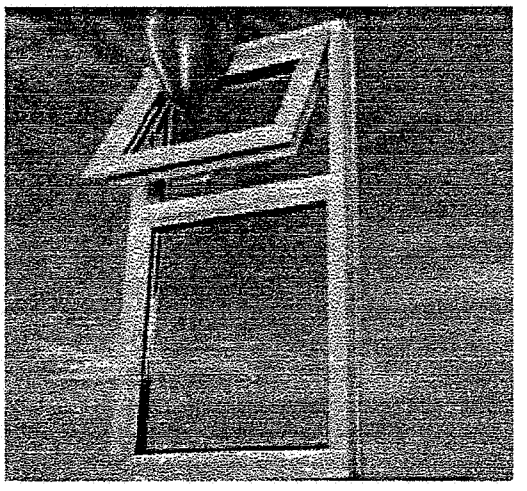
Q Heavy metals are used as heat stabilisers to allow PVC to be moulded into products. Some of them are known to be dangerous. How can you defend the use of such dangerous material?

A Substances based on certain metals are used in PVC formulations as stabilisers. In use, these materials are sealed into the polymer matrix and represent no danger to public or environmental health.

When evaluating the environmental consequences of these stabilisers, one has to consider both the amount of the stabiliser which might migrate from the plastic into the environment, and its toxic potential.

Research has shown that while migration of these compounds is possible, only a small proportion of the stabiliser will leach out of the plastic during its service life.

The use of stabilisers is also closely regulated and, in critical applications of PVC compounds, such as in toys, food contact, potable water and medical devices, there are detailed regulatory controls with positive lists of allowed materials. For these sensitive applications, calcium / zinc and organotin compounds are used, but lead also has widespread approval for use in potable water pipes.



Q It is common knowledge that when PVC burns in accidental fires, it gives off highly toxic fumes and dioxins, which increase the danger to people trapped in such fires. So why is this material used in building applications?

A One of the reasons PVC is specified for

and PVC products have been stabilised with lead compounds since the early 1930s.

Lead is the most important stabiliser for rigid PVC applications and is also used in some flexible applications - cables in particular. Lead stabilisers perform very effectively and are low in cost.

Among the principal applications using lead stabiliser systems are long-life products for the construction sector such as pressure pipes for potable water transportation, underground drainage and sewage pipes, gutters and window profiles. It is also used in flexible products such as electrical wire and cable sheathing.

Products stabilised with lead have come under pressure in recent years because of alleged hazards to man and the environment. Despite these concerns, no medically serious poisoning, as a result of using lead stabilisers in PVC, has ever been reported. Indeed, lead stabilised PVC potable water pipes have wide government approval.

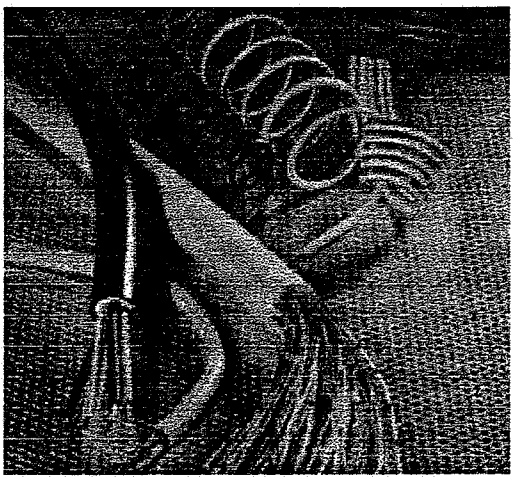
Q Why is cadmium still used as a stabiliser?

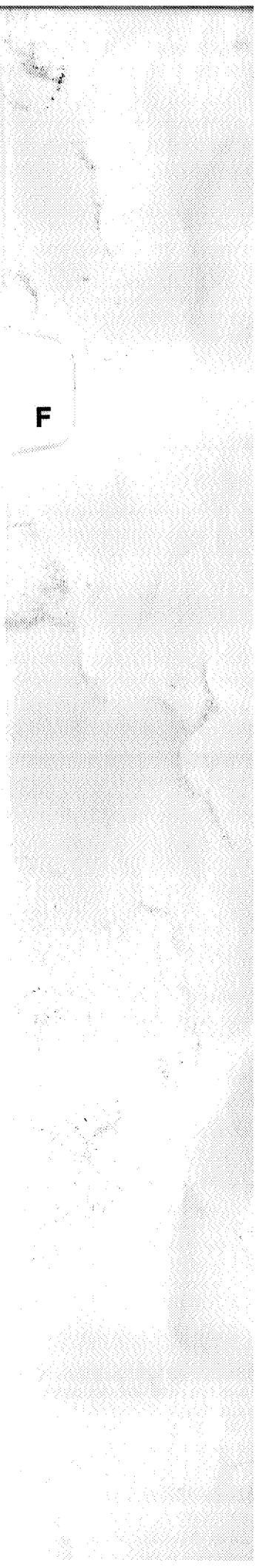
A The use of cadmium is regulated by a European Directive and is allowed in only a few applications, like window profiles. Even for such applications, the industry has already substituted cadmium-based stabilisers to a very large extent, and it is anticipated that this substitution process will be complete within a few years.

building materials and is favoured by fire authorities, is because of its excellent fire prevention properties. PVC is very difficult to ignite and, in the absence of a powerful external flame, will not continue to burn.

When PVC does burn, it releases hydrogen chloride, carbon monoxide and very little heat. But any accidental fire produces carbon monoxide and it is this gas, plus heat, which is the major cause of fire deaths. Carbon monoxide is colourless and odourless and therefore victims are not aware they are breathing it. By contrast, very small quantities of hydrogen chloride irritate the human nose and provide an early warning of fire.

Dioxins are a family of chemical substances which are produced in many types of combustion, such as cigarette smoke, car exhaust or even your home barbecue. Accidental fires are another source, but investigations of such fires have concluded that the quantities of dioxins produced have no hazardous effects. Every fire also produces poly-aromatic hydro-carbons (PAHs) which originate from all kinds of combustible, organic materials. However, PAH represents a much more serious level of risk than dioxins - a point often overlooked in the debate on accidental fires.




F

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT F

Dickens, "Costs of Plastic Pipe Not Considered or Inadequately Analyzed in the Draft Environmental Impact Report on Plastic Plumbing Pipe"

Costs of Plastic Pipe Not Considered or Inadequately Analyzed in the Draft Environmental Impact Report on Plastic Plumbing Pipe

by

Dr. William T. Dickens
Associate Professor of Economics
Department of Economics
University of California, Berkeley

Costs of Plastic Pipe

Not Considered or Inadequately

Analyzed in the Draft Environmental Impact Report

on Plastic Plumbing Pipe

by

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APPENDIX B

William T. Dickens is an Associate Professor of Economics at the University of California, Berkeley. He has been teaching at Berkeley since he received his Ph.D. in Economics from M.I.T. in 1981. He teaches Labor Economics, Econometrics and Macro Economics at both the graduate and undergraduate levels. William Dickens has also been a Research Associate of the National Bureau of Economic Research since 1983. Professor Dickens has received numerous grants and awards and has published scholarly papers on a wide range of subjects. He serves as a reviewer for the National Science Foundation and several other granting agencies and for all the major Economic journals. He has presented expert witness testimony in administrative hearings and in Federal Court.

The economic analysis presented in the Draft Environmental Impact Report on Plastic Plumbing Pipe, August 1989 (DEIR) is an inadequate and misleading indicator of the true costs of substituting plastic for metal pipe in residential construction in California.

First, only comparisons favorable to plastics are presented. Comparisons where plastics cost more than metal are mentioned but not presented.

Second, metal pipe is of proven durability, plastic is not. The DEIR assumes that the median survival time for a plastic system is 20 years. Evidence presented below suggests that copper pipe can be expected to last more than two-and-a-half times as long as plastic in most areas of California. Cast iron DWV systems last even longer. By ignoring these differences the DEIR fails to adequately analyze the differential costs of replacement and repair.

Third, the DEIR recommends a number of mitigations to deal with the environmental, worker health, and fire safety problems posed by plastic pipes. However, the economic analysis does not consider the cost of these mitigations in comparing plastic and metal pipes.

Fourth, the DEIR assumes that the entire alleged saving from using plastic will be passed on to home buyers. However, standard economic theory suggests that in developed urban areas the cost of housing depends only on the number of available lots and the demand for housing. Cost savings in construction increase the value of land but do not reduce the purchase price of a new house.

Finally, the DEIR suggests that changing the state plumbing code will provide benefits and impose costs on local governments. However, it does not adequately document them. Further analysis suggests that the costs may be significant while the benefits are small to non-existent. Each of these problems is examined below.

The DEIR's Does not Present Cost Estimates For Plastics That Cost More Than Metal.

The DEIR compares copper pipe to PB, and Cast Iron to ABS and finds metal to be marginally more expensive. Comparing copper to other plastics yields differences in the opposite direction. These comparisons are mentioned in the DEIR but not presented.

Although PVC pipe and fixtures cost considerably less than copper pipe they require more hangers. Hanging and joining the pipe properly requires considerably more labor. These additional costs

make installed PVC more expensive than Copper. CPVC pipe costs more than copper and requires additional labor and hangers for installation. For the plumbing system for the "Moderately Large House" described in the ERD's tables II-2&3 we estimate the cost of copper for the PW system to be $228.55 less than the cost of PVC and $904.87 less than the cost of CPVC (see Appendix A). These cost estimates assume the procedures recommended in Means (1988).

Table 1

Costs of Copper, PVC and CPVC
Potable Water Systems

	Copper	PVC	CPVC
Materials	$286.82	$216.20	$653.02
Labor	$1,752.44	$2,051.61	$2,291.11
Total Cost	$2,039.26	$2,267.81	$2,944.13

The DEIR's Comparisons Do Not Take Into Account A Number of Additional Costs of Using Plastic Pipe.

The DEIR Comparisons Do Not Take Into Account Differences in Replacement Costs for Plastics and Metal.

Metal pipes, particularly copper and cast iron, have been in use for many years and are of proven durability. Depending on the corrosive properties of the water, copper pipe can be expected to last anywhere from thirty to two-hundred years. Cast iron pipe appears to be able to out last most buildings. Some of the original cast iron plumbing systems, installed 400 years ago, are still in use today.

When water is corrosive, treatment can greatly extend pipe life. California's Public Health Code requires such treatment (CAHSC).[1] A recent study done for the American Water Works Association (EESI,1989) found that, on average, copper pipe can be expected to last 49 years. However, California water tends to be less corrosive than the average water in the U.S.. Copper pipes in Champaign Ill. lasted over 80 years on average. Champaign has water which is very similar to that of LA. A survey of plumbers in LA, and cities served by the East Bay Municipal District (EBMUD) found

[1]. Tighter federal standards have recently been proposed by the EPA and may be adopted.

that copper pipes in those areas lasted 73 and 55 years respectively on average (EESI, 1989).

Using the data on these water districts, Champaign Il., and Vancouver B.C. the expected copper pipe life for three additional California water districts serving approximately ten million people has been estimated. The projected life expectancies range from a minimum of 42 years to a maximum of 74 years. On average the estimates suggest a mean pipe life of over 62 years. Combining these data with those for LA and EBMUD the population weighted mean pipe life is 64 years for water from five water districts covering 60 percent of California's population (see Appendix B). This is over three times the life assumed for plastic pipe in the DEIR (top and again on the bottom of p88).

The DEIR states that "Available data do not convincingly demonstrate that metal and plastic systems differ significantly in frequency of damage or failure, cost to repair[2], or service lives (p88)." While existing data are not absolutely conclusive -- given the short time plastic pipe has been in use it is impossible to imagine how they could be -- the evidence cited above strongly suggests the possibility that metal systems will outlive plastic systems[3] so the potential costs should be considered.

Accepting the DEIR's assumption that plastic pipe has a mean life expectancy of 20 years and concluding from the above data that metal pipes in California have a mean life expectancy of 50 to 80 years it is possible to compare the present value of the expected costs of replacement for the two types of systems. To conduct the analysis it is assumed that the average house will last 50 years, that construction cost inflation will continue at the average rate for the last twenty years (6.25%) and that the current cost of replacing accessible plumbing is $3200.[4] Table 2 contains the

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[2]. Despite this at the bottom of the same page the DEIR claims a replacement cost advantage for PB by assuming that the cost of replacement would be the same as the cost of installation, that a copper system will only last twenty years and that the system will only have to be replaced once in the life of a house. In the same paragraph the DEIR also claims an additional saving for plastic over copper of $70 a year in maintenance costs when water is corrosive.

[3] See also the evidence of frequent mechanical failure in plastic pipe systems in the Thomas report (attached).

[4]. The assumption of a 50 year life for new housing is conservative and common use in the engineering literature. The data on construction price inflation come from Means (1989). The cost of replacement comes from the AWWA study (EESI, 1989). We

present value of replacement costs for two different discount rates -- the return on 3 month treasury bills for the last twenty years and the average interest rate on an FHA fixed rate mortgage over the same period.[5]

Table 2

PRESENT VALUE OF THE COST OF REPLACING

ACCESSIBLE INFLOW PIPES

(Cost Advantage of Plastic in Parentheses)

	Type of Pipe		
	Plastic	Metal	
	20 years	50 years	80 years
Discount Rate:			
Treasury Bills			
7.5%	$4,346	$1,263	$585
		($3,083)	($3,761)
FHA Mortgages			
10.7%	$2,085	$527	$230
		($1,558)	($1,855)

(FHA mortgages is secondary market yield on insured loans. Present value of replacement costs may exceed the current cost of a one time replacement if the system is expected to fail more than once during the life of a house.)

Assuming equal current costs for a one time replacement the estimated difference in the present value of replacement costs between plastic and metal range from plastic being $1,558 to $3,761 more expensive. Even if current one-time replacement costs for plastic were 50% less than those for metal the present value of replacement costs would be greater because of the greater frequency of replacement and the necessity of replacing it sooner. However, savings in replacement costs are likely to be proportionally less than the savings, if any, for installation since replacement of even "accessible" pipes will require some carpentry work and that work will be necessary for either type of system.

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also assume that both pipes and houses have a Weibull survivor curve with a coefficient of 2.

[5]. Appendix C presents the model used to make these calculations

These are very conservative estimates. Increasing the assumed life expectancy of houses, extending the time horizon over which the inflation and discount rates are computed or allowing for the possibility that replacement of more than accessible plumbing may be necessitated by some problems, would increase the cost advantage of metal.[6]

The DEIR Comparisons Do Not Take Into Account Differences in Repair Costs for Plastics and Metal.

In addition to replacement costs it is typical to assume that plumbing will require three repairs coming in the last ten years of the life of the system (Kirmeyer et. al. 1983). If copper systems in California last 64 years and plastic systems last 20 the present value of repair costs for a copper system will be between $168 and $211 less than that for a plastic system if repair costs are the same. Even if the plastic systems cost as little as 1/3 as much as metal to repair, the present value of future repair costs may be greater for plastic.

Table 3

Repair Costs of Plastic and Metal Systems

	Type of Pipe		
	Plastic 20 years	Metal 64 years	Difference
Discount Rate:			
Treasury Bills 7.5%	$393.13	$225.62	$167.51

[6]. Kirmeyer et. al. (1983) suggest that total replacement of a system can cost as much as three times more than replacing only accessible pipes. If this were the case the dollar differences between metal and plastic would be three times greater.

FHA Mortgages 10.7%	$157.53	$36.32	$210.78

(FHA mortgages is secondary market yield on insured loans. Treasury Bills is the yield on 3 month Treasury Bills.)

It is worth noting that the costs of repair and replacement are hidden costs. People buying new houses will often be unaware of the type of plumbing in their houses. They may not receive the cost saving, if any, from the installation of plastics, but they will certainly have to bear any additional costs for repair and replacement.

The DEIR's Estimates Ignore the Cost of Recommended Mitigations

The DEIR recommends three mitigations for environmental, fire and worker safety hazards caused by the expanded use of plastic pipes that will add significantly to the cost of plumbing. However, the comparisons presented in the DEIR ignore these additional costs.

Flushing:

In order to protect workers and occupants from drinking water contaminated with potentially dangerous chemicals the DEIR recommends a procedure for flushing plastic pipe to wash out the chemicals. The flushing procedure will require a plumber to travel to the construction site on at least two occasions after work has been completed.[7] In areas where building inspectors do not run water from every faucet three trips will be required. Assuming, conservatively, that one way travel time will be 1/2 hour the additional cost per building will be $192 for two trips and $288 for three trips[8].

Ventilation:

In order to protect workers from the fumes created by the use of chemical solvents to join pipes, the DEIR recommends ventilation

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[7]. Since water fixtures are some of the last things installed in a house it will be necessary for someone to travel to the site after work has been completed.

[8]. Although the flushing procedure should take less than an hour for most jobs plumbers typically bill in one hour increments. Travel time is included since plumbers bill door-to-door. We assume a labor cost of $48/hr.

of the work area. A standard for appropriate ventilation technique has not been established. A survey of existing methods suggest that they may add as much as $100 to the cost of a job if the best available equipment is used.

Fire Prevention:

Metal pipe does not burn and melts only at very high temperatures. Metal pipes can penetrate fire walls without compromising the integrity of the fire wall. Plastic pipes melt at relatively low temperatures and can burn. When plastic pipes penetrate fire walls they reduce the effectiveness of the wall in stopping the spread of fire. The DEIR recommends that if increased use of plastic pipe is allowed, building and fire codes should be changed to specify special installation procedures to slow down the spread of fire. However, the DEIR does not specify what procedures should be used. The Plastic Pipe Fitting Association (1985) has conducted studies and claims that the one hour rating for fire walls can be obtained by the use of spackle and/or metal escutcheons at the point were the pipes pass through the fire wall. Such measures will add only insignificantly to the cost of plumbing (phone conversations with several plumbing contractors, Oct. 1989).

However, it is possible that local building inspectors will not have the expertise necessary to evaluate these devices. Since the installation of many of these fire stopping devices require the presence of the inspector many municipalities may not have the resources to provide for these inspections. In either case special inspectors will have to be hired and may require several trips to the construction site. Such special inspections will add a minimum of $150 to the cost of each unit in a multi-story building. In addition, these simple proposed measures have not yet been approved. If more extensive measures are necessary they will cost considerably more.

The DEIR's Assumption That Construction Cost Savings Will Be Passed on in Full to Home Buyers is Incorrect

When any amount of a good can be produced at a fixed cost that cost will determine the goods price. However, when the quantity of a good that can be produced is limited the price will be determined by the demand for the good. The cost of producing it will be irrelevant to the selling price. It seems reasonable to assume that in many urban areas in California all land within normal commuting distance of the central city has been developed and the quantity of housing available to those who wish to work in the central city is essentially fixed. In such an environment the price of housing, even the price of a new house constructed on an

old lot, will be unaffected by the cost of building new housing. Rather, any reduction in construction costs will simply increase the value of land. Only in rural areas or in urban fringe areas (where housing costs are relatively low) is it likely that the cost of building new housing will affect the price of housing.

The same should be true for rent. In fully developed urban areas (where rents are highest) rent is probably unaffected by the cost of constructing new rental housing and is determined only by the demand for housing. Again, savings on construction costs will only increase the value of land.

Because of Inadequate Analysis the DEIR Overestimated the Benefits and Underestimates Additional Costs of Substituting Plastic for Metal Pipe

There are problems in five additional areas with the analysis presented in the DEIR:

Corrosion Control

The DEIR suggests that allowing the use of plastic pipe could save up to $70 per plumbing system on corrosion control. Corrosion control is not a problem for building owners in California for two reasons. First, as documented above, California has some of the least corrosive water in the nation. The major urban areas of California have access to water which either is not even moderately corrosive or is easily treated. Second, in areas of California where water is corrosive the water is treated by the purveyor. This is required by California law (CAHSC). But even if the adoption of the proposed revisions led to the wide-spread use of plastics it would be years before the amount of metal pipe in districts requiring corrosion control would be sufficiently low that it would no longer be cost-effective to treat the water. These savings would likely be so far in the future that their net present value, using reasonable discount rates, would be insignificant.

Requests for Variances

The DEIR suggests that allowing more extensive use of plastic pipe will save local governments money because they will have to process fewer requests for variances to the plumbing code requesting the use of plastic pipes. In conversations with plumbing inspectors in five local municipalities (listed in Appendix E) we were unable to discover a single case where such a variance has been requested. Miguel Mejia, State Housing Law Program Manager of the State Department of Housing and Community Development stated that although local jurisdictions could potentially grant variances for individual job sites he has never

heard of any such requests (phone conversation Oct. 1989).

Corrosion in Delivery Systems

The DEIR cites Ryder's (1980) estimate of the cost of corrosion to the Seattle municipal water district of $400,000 and suggests that allowing greater use of plastic pipes in residential systems might allow savings of this magnitude in California municipalities. The logic here is very difficult to understand. Why would the introduction of plastic pipe in residential units reduce the cost of corrosion of metal pipes in municipal distribution systems? Perhaps the authors of the DEIR have misunderstood Ryder and have interpreted this as the cost of anti-corrosion water treatment. As noted above, no such savings are likely to accrue in the near future and any savings in the long run would have negligible net-present-value.

Inspection Costs

The DEIR mentions the possibility that costs of inspecting new buildings would increase if the proposed changes were adopted, but they fail to attach any cost to this possibility. In fact there would be substantial costs. Because of the greater care which is necessary for installation, and because of the requirements to insure fire safety, inspections will be much more expensive. This is discussed above in the section on fire mitigations.

Costs Due to Danger of Fumes From Burning Pipes

The DEIR dismisses the possibility that fumes from burning pipes could be a cause for concern outside the building containing the pipes. Yet several buildings in downtown Calgary were evacuated in September of this year when burning PVC pipe in a outdoor work pit sent hydrogen chloride gas into the street and nearby buildings. Estimates of the cost of lost business due to the evacuation range as high as a million dollars (See Appendix F).

In conclusion, the positive impacts of wider use of plastic pipe on public service costs identified by the DEIR seem entirely ephemeral. On the other hand there are significant costs which the DEIR fails to document. Moreover, these are all costs which are "external" to the people who would be deciding to install the pipe. Such external costs can be expected to lead to a greater use of plastic pipe than is socially optimal.

Conclusion

The economic analysis of the DEIR does not adequately address the costs of allowing increased use of plastic pipes in residential construction. The much higher costs of substituting other plastics

for copper are not presented. The analysis of repair and replacement costs is incomplete and inadequate. A more realistic appraisal suggests that there may be substantial hidden expenses to using plastics that will cost home owners as much as $3,972 in present value terms over the lives of their houses. Further, the DEIR suggests several expensive mitigations, but fails to consider them in comparing the costs of plastic systems with those of metal systems. We estimate that these mitigations would add at least $200 to the construction costs of a new single-family house.

Further, the DEIR suggests that the full value of any savings will be passed on to the renter or the home buyer. According to standard economic analysis this would only be certain in rural or urban fringe areas where housing prices and rents are relatively low.

Finally, the DEIR claims a potential savings from reduced costs of processing requests for plumbing code variances, reduced corrosion costs and reduced corrosion control costs when in fact their will be very little or no savings. On the other hand the DEIR fails to present the large costs of more involved inspections that would be necessitated by the proposed changes.

Besides the fact that consideration of all costs makes the difference between plastic and metal negligible -- or even favor metal -- it is important to note that plastic pipe may seem cheaper when only the direct costs are considered. Thus there will be a tendency for plastic pipe to be over-used. There will be a temptation for builders to save money by using plastic pipe. When they do they will impose substantial costs on the community and the home or building owner. These costs may be greater than the builder's savings.

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Appendix A

Costs of Plastic and Copper Potable Water Systems

Specifications from ERD Table II-2

(Cost data are from Means 1988 except where noted)

Cost Analysis
COPPER
Inflow - Potable Water (PW)

Component	Size	Quantity	Per Unit Material	Per Unit Labor	Total	Total (noP&O)
(1)	(2)	(3)	(4)	(5)	(6)=4+5	(7)=6*3
Pipe-M						
incl cplr&hngr	1/2"	165	$0.65	$2.33	$2.98	$491.70
incl cplr&hngr	3/4"	134	$0.95	$2.51	$3.46	$463.64
Solder	lb	2	$10.70	$0.00	$10.70	$21.40
Flux	oz	6	$0.88	$0.00	$0.88	$5.28
Elbows						
C x C 90deg	1/2"	43	$0.15	$9.80	$9.95	$427.85
C x C 90deg	3/4"	26	$0.32	$10.30	$10.62	$276.12
C x C 45deg	1/2"	6	$0.29	$9.80	$10.09	$60.54
C x C 45deg	3/4"	1	$0.49	$10.30	$10.79	$10.79
Tees						
C x C x C	1/2"	3	$0.25	$15.05	$15.30	$45.90
C x C x C	3/4"	14	$0.56	$16.30	$16.86	$236.04
					TOTAL	$2,039.26

Notes
1. Solder and flux priced from retail hardware store.
2. Ftg x C and C x C elbows counted and priced with C x C elbows.
3. Drop ear elbow counted and priced as a 45deg 1/2" elbow.
4. Reduce on run tee counted and priced as 3/4" tee.
5. To delete cplngs and hngrs, substract 35% for mat, 65% for lab.
6. 100% of components from Table II-3, excl. PVC pipe and taxes.

Cost Analysis
CPVC - Sched. 40
Inflow - Potable Water (PW)

Component	Size	Quantity	Per Unit Material	Per Unit Labor	Total	Total (noP&O)
(1)	(2)	(3)	(4)	(5)	(6)=4+5	(7)=6*3
Pipe						
incl cplr&hngr	1/2"	165	$1.26	$3.62	$4.88	$805.20
incl cplr&hngr	3/4"	134	$1.50	$3.84	$5.34	$715.56
Elbows						
90deg	1/2"	43	$1.95	$10.85	$12.80	$550.40
90deg	3/4"	26	$2.48	$11.50	$13.98	$363.48
45deg	1/2"	6	$2.91	$16.30	$19.21	$115.26
45deg	3/4"	1	$4.64	$17.80	$22.44	$22.44
Tees						
	1/2"	3	$2.91	$16.30	$19.21	$57.63
	3/4"	14	$4.64	$17.80	$22.44	$314.16
					TOTAL	$2,944.13

Notes
1. Ftg x C and C x C elbows counted and priced with C x C elbows.
2. Drop ear elbow counted and priced as a 45deg 1/2" elbow.
3. Reduce on run tee counted and priced as 3/4" tee.
4. To delete cplngs and hngrs, substract 37% for mat, 77% for lab.
5. Using CU ftg set for CPVC because it is inflexible pipe.
6. Fittings are Schedule 80.
7. 100% of components from Table II-3, excl. PVC pipe and taxes

Cost Analysis
PVC - Sched. 40
Inflow - Potable Water (PW)

Component	Size	Quantity	Per Unit Material	Per Unit Labor	Total	Total (noP&O)
(1)	(2)	(3)	(4)	(5)	(6)=4+5	(7)=6*3
Pipe						
incl cplr&hngr	1/2"	165	$0.64	$3.62	$4.26	$702.90
incl cplr&hngr	3/4"	134	$0.69	$3.84	$4.53	$607.02
Elbows						
90deg	1/2"	43	$0.17	$8.90	$9.07	$390.01
90deg	3/4"	26	$0.19	$9.30	$9.49	$246.74
45deg	1/2"	6	$0.27	$8.90	$9.17	$55.02
45deg	3/4"	1	$0.42	$9.30	$9.72	$9.72
Tees						
	1/2"	3	$0.21	$13.95	$14.16	$42.48
	3/4"	14	$0.23	$15.05	$15.28	$213.92
					TOTAL	$2,267.81

Notes
1. Ftg x C and C x C elbows counted and priced with C x C elbows.
2. Drop ear elbow counted and priced as a 45deg 1/2" elbow.
3. Reduce on run tee counted and priced as 3/4" tee.
4. To delete cplngs and hngrs, substract 65% for mat, 74% for lab.
5. Using CU ftg set for PVC because it is inflexible pipe.
6. 100% of components from Table II-3, excl. PVC pipe and taxes

Appendix B

Estimating the Life of Copper Pipe for California

To obtain estimates for pipe life for districts for which survey data are not available the pipe life for known districts was regressed on the indices of corrosiveness and then expected pipe life was interpolated from the regressions. All data are from EESI (1989).

Data for Regressions:

District	Pipe Life	ph	Corrosivity Index Langlier	Agress.	Larson
LA	73	8.3	0.3	12.2	0.4
EBMUD	55	9.3	-0.4	11.9	0.2
Vancouver	30	5.7	-5.5	6.5	2.8
Champaign	80	8.85	0.4	13.1	0.4

PH Regression equation:

Regression Output:	
Constant	-26.8839
Std Err of Y Est	17.30658
R Squared	0.598770
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	10.74452
Std Err of Coef.	6.219256

Langlier Regression equation:

Regression Output:	
Constant	69.09212
Std Err of Y Est	9.829441
R Squared	0.870572
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	7.331564
Std Err of Coef.	1.998909

Aggressivity Regression equation:

Regression Output:	
Constant	-16.3745
Std Err of Y Est	9.482869
R Squared	0.879538
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	6.950337
Std Err of Coef.	1.818814

Larson Regression equation:

Regression Output:	
Constant	73.88458
Std Err of Y Est	14.60483
R Squared	0.714264
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	-14.9522
Std Err of Coef.	6.687174

Interpolated Pipe lives based on Indices

District	Ph	Langlier	Agress.	Larson	Average
MWDSC - colorado	60.9	73.5	71.2	42.5	62
MWDSC - state pjt.	58.8	69.1	66.3	52.9	62
SF	58.8	70.6	60.8	64.9	64
Contra Costa	63.1	69.1	66.3	42.5	60

Using the average of the interpolated pipe lives for each district, and the known lives where available, the population weighted average pipe life for California districts was calculated:

District	Pipe life	Population
LA	73	3.4
MWDSC	62	7.35
EBMUD	55	1.1
SF	64	2
Contra Costa	60	0.35
Sum		14.2
Average	64	

Note1: Data for Vanccuver is averaged based on average daily flow the three sources. EESI p 152,3. Rest of data is from p 149 an from p 28, and case studies section.

Note2: LA uses about 75% owens water, but pipe life is for all LA

Note3: Pop is population served in millions. MWDSC is a wholesaler selling to 27 districts that serve 14.7 million people. But MWDSC only supplies approximately 50% of those districts water. One districts is Los Angeles which gets 5-15% of its water from MWDSC

Appendix C

Analysis of Replacement Costs of Copper and Plastic Systems

The model used to analyze the differential replacement costs of copper and plastic systems was implemented using Lotus 123. The spread sheet is printed below and below that is a listing of the formulas.

Briefly, the model uses a Weibull survivor curve to estimate the number of pipe systems failing in each year. The present value of the cost of replacement is then computed and the values for each year added together with each year being weighted by the fraction of the housing stock still surviving. That fraction is also computed using the Weibull survivor curve. The model keeps track of systems that fail and are replaced and then computes for each new vintage the failure rate for subsequent years. These costs are also added in.

Spread Sheet

1	B	C	D	E	F	G
2						
3	PARAMETERS					
4						
5	Descriptions			Name	Value	
6						
7	AVERAGE PIPE LIFE			MEAN	20	
8	COEF. C			CPIPES	2	
9	AVERAGE HOUSE LIFE			HOME	50	
10	COEF. C FOR HOUSES			CHOUSES	2	
11	INTEREST RATE			IR	0.10704	
12	REPLACEMENT COST			RLCOS	3200	
13	INFLATION			INFL	0.0625025	
14						
15	RESULTS					
16						
17	TOTAL PDV REPLACEMENT COST			TOTAL	$2,084.78	
18						
19						
20						
21	CALCULATION PIPE FAILURES BY VINTAGE					
22						
23						
24		Prob. of	Failures	Failures		
25		Failure	in Vintage	in Vintage		
26	Year (t)		1	2		

27	1	0.002022	0.00202295
28	2	0.008067	0.00604433
29	3	0.018059	0.00999264
30	4	0.031880	0.01382081
31	5	0.049364	0.01748416
32	6	0.070306	0.02094129
33	7	0.094461	0.02415485
34	8	0.121553	0.02709219
35	9	0.151279	0.02972593
36	10	0.183313	0.03203432
37	11	0.217315	0.03400151
38	12	0.252932	0.03561766
39	13	0.289811	0.03687890
40	14	0.327598	0.03778713
41	15	0.365948	0.03834970
42	16	0.404527	0.03857901
43	17	0.443019	0.03849201
44	18	0.481129	0.03810953
45	19	0.518584	0.03745570
46	20	0.555141	0.03655722
47	21	0.590584	0.03544267
48	22	0.624726	0.03414182
49	23	0.657411	0.03268498
50	24	0.688513	0.03110231
51	25	0.717937	0.02942332
52	26	0.745613	0.02767632
53	27	0.771501	0.02588798
54	28	0.795584	0.02408302
55	29	0.817868	0.02228387
56	30	0.838378	0.02051054
57	31	0.857159	0.01878045
58	32	0.874267	0.01710840
59	33	0.889774	0.01550660
60	34	0.903759	0.01398473
61	35	0.916309	0.01255007
62	36	0.927516	0.01120766
63	37	0.937477	0.00996049
64	38	0.946286	0.00880972
65	39	0.954041	0.00775490
66	40	0.960836	0.00679421
67	41	0.966760	0.00592468
68	42	0.971903	0.00514242
69	43	0.976346	0.00444283
70	44	0.980166	0.00382079
71	45	0.983437	0.00327083
72	46	0.986225	0.00278732
73	47	0.988589	0.00236454
74	48	0.990586	0.00199685
75	49	0.992265	0.00167879
76	50	0.993670	0.00140508
77	51	0.994841	0.00117077

78	52	0.995812	0.00097122
79	53	0.996614	0.00080211
80	54	0.997273	0.00065954
81	55	0.997813	0.00053993
82	56	0.998253	0.00044007
83	57	0.998611	0.00035712
84	58	0.998899	0.00028854
85	59	0.999131	0.00023212
86	60	0.999317	0.00018592
87	61	0.999465	0.00014828
88	62	0.999583	0.00011774
89	63	0.999676	0.00009309
90	64	0.999750	0.00007329
91	65	0.999807	0.00005745
92	66	0.999852	0.00004484
93	67	0.999887	0.00003485
94	68	0.999914	0.00002697
95	69	0.999934	0.00002078
96	70	0.999950	0.00001594
97	71	0.999963	0.00001218
98	72	0.999972	0.00000927
99	73	0.999979	0.00000702
100	74	0.999984	0.00000529
101	75	0.999988	0.00000398
102	76	0.999991	0.00000297
103	77	0.999993	0.00000221
104	78	0.999995	0.00000164
105	79	0.999996	0.00000121
106	80	0.999997	0.00000089
107	81	0.999998	0.00000065
108	82	0.999998	0.00000047
109	83	0.999999	0.00000034
110	84	0.999999	0.00000025
111	85	0.999999	0.00000018
112	86	0.999999	0.00000012
113	87	0.999999	0.00000009
114	88	0.999999	0.00000006
115	89	0.999999	0.00000004
116	90	0.999999	0.00000003
117	91	0.999999	0.00000002
118	92	0.999999	0.00000001
119	93	0.999999	0.00000001
120	94	0.999999	0.00000000
121	95	0.999999	0.00000000
122	96	0.999999	0.00000000
123	97	0.999999	0.00000000
124	98	0.999999	0.00000000
125	99	0.999999	0.00000000
126	100	0.999999	0.00000000
127			
128			

CALCULATION OF PDV OF COST OF REPLACEMENT OF PIPES

YEARS	TOTAL PDV COST	SURVIVING HOUSES	DISCOUNT FACTOR	PIPES REPLACED	REPLAC. COST
1	6.210996	0.99967605	0.90330972	0.0020229	3400.00
2	17.80585	0.99870483	0.81596846	0.0060484	3612.51
3	28.25704	0.99708824	0.73707224	0.0100171	3838.30
4	37.54172	0.99482941	0.66580453	0.0138978	4078.21
5	45.65484	0.99193271	0.60142770	0.0176612	4333.11
6	52.60855	0.98840376	0.54327550	0.0212800	4603.94
7	58.43097	0.98424935	0.49074604	0.0247298	4891.69
8	63.16459	0.97947751	0.44329567	0.0279895	5197.44
9	66.86445	0.97409738	0.40043329	0.0310415	5522.29
10	69.59609	0.96811925	0.36171529	0.0338718	5867.45
11	71.43340	0.96155453	0.32674094	0.0364707	6234.18
12	72.45621	0.95441566	0.29514826	0.0388318	6623.83
13	72.74824	0.94671611	0.26661030	0.0409530	7037.84
14	72.39522	0.93847036	0.24083167	0.0428357	7477.72
15	71.48280	0.92969379	0.21754559	0.0444848	7945.10
16	70.09477	0.92040268	0.19651105	0.0459083	8441.69
17	68.31164	0.91061416	0.17751034	0.0471169	8969.31
18	66.20935	0.90034613	0.16034682	0.0481238	9529.92
19	63.85829	0.88961721	0.14484284	0.0489438	10125.5
20	61.32266	0.87844673	0.13083795	0.0495932	10758.4
21	58.65994	0.86685461	0.11818719	0.0500893	11430.8
22	55.92074	0.85486133	0.10675964	0.0504499	12145.3
23	53.14874	0.84248788	0.09643702	0.0506928	12904.4
24	50.38092	0.82975566	0.08711250	0.0508353	13711.0
25	47.64782	0.81668648	0.07868956	0.0508945	14567.9
26	44.97407	0.80330243	0.07108105	0.0508862	15478.5
27	42.37884	0.78962589	0.06420820	0.0508250	16445.9
28	39.87646	0.77567939	0.05799989	0.0507245	17473.8
29	37.47701	0.76148561	0.05239187	0.0505964	18566.0
30	35.18695	0.74706730	0.04732608	0.0504512	19726.4
31	33.00970	0.73244721	0.04275011	0.0502977	20959.4
32	30.94618	0.71764805	0.03861659	0.0501432	22269.4
33	28.99538	0.70269242	0.03488274	0.0499935	23661.3
34	27.15474	0.68760275	0.03150992	0.0498530	25140.2
35	25.42065	0.67240126	0.02846322	0.0497250	26711.5
36	23.78869	0.65710989	0.02571110	0.0496115	28381.0
37	22.25402	0.64175029	0.02322509	0.0495137	30154.9
38	20.81151	0.62634371	0.02097944	0.0494319	32039.7
39	19.45600	0.61091099	0.01895094	0.0493658	34042.2
40	18.18241	0.59547254	0.01711856	0.0493143	36170.0
41	16.98581	0.58004824	0.01546337	0.0492764	38430.7
42	15.86153	0.56465745	0.01396821	0.0492504	40832.7
43	14.80516	0.54931897	0.01261762	0.0492348	43384.9
44	13.81261	0.53405096	0.01139762	0.0492277	46096.5
45	12.88004	0.51887099	0.01029558	0.0492275	48977.7
46	12.00394	0.50379592	0.00930009	0.0492326	52038.9

180	47	11.18104	0.48884197	0.00840087	0.0492414	55291.5
181	48	10.40831	0.47402462	0.00758858	0.0492527	58747.3
182	49	9.682968	0.45935865	0.00685484	0.0492652	62419.2
183	50	9.002385	0.44485806	0.00619204	0.0492780	66320.5
184	51	8.364134	0.43053614	0.00559333	0.0492903	70465.8
185	52	7.765929	0.41640538	0.00505251	0.0493016	74870.0
186	53	7.205617	0.40247753	0.00456398	0.0493113	79549.6
187	54	6.681158	0.38876353	0.00412269	0.0493192	84521.7
188	55	6.190615	0.37527356	0.00372406	0.0493253	89804.5
189	56	5.732144	0.36201703	0.00336398	0.0493293	95417.5
190	57	5.303981	0.34900256	0.00303872	0.0493314	101381.
191	58	4.904442	0.33623801	0.00274490	0.0493317	107717.
192	59	4.531910	0.32373046	0.00247950	0.0493304	114450.
193	60	4.184840	0.31148627	0.00223975	0.0493276	121604.
194	61	3.861751	0.29951104	0.00202319	0.0493236	129204.
195	62	3.561224	0.28780963	0.00182757	0.0493186	137280.
196	63	3.281905	0.27638623	0.00165086	0.0493128	145860.
197	64	3.022499	0.26524429	0.00149124	0.0493065	154977.
198	65	2.781770	0.25438663	0.00134705	0.0492997	164663.
199	66	2.558544	0.24381537	0.00121680	0.0492926	174955.
200	67	2.351701	0.23353203	0.00109915	0.0492855	185890.
201	68	2.160180	0.22353752	0.00099287	0.0492784	197509.
202	69	1.982975	0.21383213	0.00089687	0.0492714	209854.
203	70	1.819133	0.20441562	0.00081015	0.0492645	222970.
204	71	1.667755	0.19528719	0.00073182	0.0492579	236906.
205	72	1.527990	0.18644555	0.00066106	0.0492514	251714.
206	73	1.399038	0.17788891	0.00059714	0.0492453	267447.
207	74	1.280146	0.16961501	0.00053940	0.0492394	284163.
208	75	1.170604	0.16162119	0.00048724	0.0492337	301924.
209	76	1.069746	0.15390434	0.00044013	0.0492282	320795.
210	77	0.976949	0.14646101	0.00039758	0.0492229	340845.
211	78	0.891627	0.13928737	0.00035913	0.0492178	362149.
212	79	0.813232	0.13237929	0.00032441	0.0492128	384784.
213	80	0.741250	0.12573232	0.00029304	0.0492079	408834.
214	81	0.675204	0.11934175	0.00026471	0.0492032	434387.
215	82	0.614644	0.11320261	0.00023911	0.0491985	461538.
216	83	0.559154	0.10730972	0.00021599	0.0491938	490385.
217	84	0.508345	0.10165769	0.00019511	0.0491891	521035.
218	85	0.461853	0.09624098	0.00017624	0.0491845	553601.
219	86	0.419341	0.09105386	0.00015920	0.0491798	588203.
220	87	0.380496	0.08609051	0.00014381	0.0491751	624967.
221	88	0.345025	0.08134499	0.00012990	0.0491704	664029.
222	89	0.312658	0.07681126	0.00011734	0.0491657	705532.
223	90	0.283144	0.07248323	0.00010599	0.0491610	749630.
224	91	0.256249	0.06835476	0.00009574	0.0491562	796484.
225	92	0.231759	0.06441968	0.00008649	0.0491514	846266.
226	93	0.209473	0.06067181	0.00007812	0.0491465	899160.
227	94	0.189208	0.05710497	0.00007057	0.0491417	955360.
228	95	0.170792	0.05371301	0.00006375	0.0491368	1015072
229	96	0.154069	0.05048979	0.00005758	0.0491319	1078517
230	97	0.138893	0.04742925	0.00005201	0.0491270	1145927

231	98	0.125131	0.04452537	0.00004698	0.0491220	1217550
232	99	0.112659	0.04177220	0.00004244	0.0491171	1293650
233	100	0.101365	0.03916389	0.00003834	0.0491122	1374506
234						
235	TOTAL	2084.776				

Listing of Formulas

```
B3: [W8] 'PARAMETERS
B5: [W8] 'Descriptions
E5: [W11] 'Name
F5: [W10] ^Value
B7: [W8] 'AVERAGE PIPE LIFE
E7: [W11] 'MEAN
F7: [W10] 20
B8: [W8] 'COEF. C FOR PIPES
C8: [W9] '
E8: [W11] 'CPIPES
F8: [W10] 2
B9: [W8] 'AVERAGE HOUSE LIFE
E9: [W11] 'HOME
F9: [W10] 50
B10: [W8] 'COEF. C FOR HOUSES
E10: [W11] 'CHOUSES
F10: [W10] 2
B11: [W8] 'INTEREST RATE
E11: [W11] 'IR
F11: [W10] 0.10704
B12: [W8] 'REPLACEMENT COST
E12: [W11] 'RLCOS
F12: [W10] 3200
B13: [W8] 'INFLATION
E13: [W11] 'INFL
F13: [W10] ((207.1/61.6)^(1/20))-1
B15: [W8] 'RESULTS
B17: [W8] 'TOTAL PDV REPLACEMENT COST
E17: [W11] 'TOTAL
F17: (C2) [W10] +$TOTAL
B21: [W8] 'CALCULATION PIPE FAILURES BY VINTAGE
B23: [W8] '
C23: [W9] '
D23: [W11] '
C24: [W9] ^Prob. of
D24: [W11] ^Failures
E24: [W11] ^Failures
C25: [W9] ^Failure
D25: [W11] ^in Vintage
E25: [W11] ^in Vintage
B26: [W8] "Year (t)
C26: [W9] '
D26: [W11] 1
E26: [W11] 2
B27: [W8] 1
C27: [W9] 1-(@EXP(-(0.9*B27/$MEAN)^$CPIPES))
```

```
D27: [W11] +C27
F27: [W10] '
B28: [W8] 2
C28: [W9] 1-(@EXP(-(0.9*B28/$MEAN)^$CPIPES))
D28: [W11] +C28-C27
B29: [W8] 3
C29: [W9] 1-(@EXP(-(0.9*B29/$MEAN)^$CPIPES))
D29: [W11] +C29-C28
B30: [W8] 4
C30: [W9] 1-(@EXP(-(0.9*B30/$MEAN)^$CPIPES))
D30: [W11] +C30-C29
B31: [W8] 5
C31: [W9] 1-(@EXP(-(0.9*B31/$MEAN)^$CPIPES))
D31: [W11] +C31-C30
B32: [W8] 6
C32: [W9] 1-(@EXP(-(0.9*B32/$MEAN)^$CPIPES))
D32: [W11] +C32-C31
B33: [W8] 7
C33: [W9] 1-(@EXP(-(0.9*B33/$MEAN)^$CPIPES))
D33: [W11] +C33-C32
B34: [W8] 8
C34: [W9] 1-(@EXP(-(0.9*B34/$MEAN)^$CPIPES))
D34: [W11] +C34-C33
B35: [W8] 9
C35: [W9] 1-(@EXP(-(0.9*B35/$MEAN)^$CPIPES))
D35: [W11] +C35-C34
B36: [W8] 10
C36: [W9] 1-(@EXP(-(0.9*B36/$MEAN)^$CPIPES))
D36: [W11] +C36-C35
B37: [W8] 11
C37: [W9] 1-(@EXP(-(0.9*B37/$MEAN)^$CPIPES))
D37: [W11] +C37-C36
B38: [W8] 12
C38: [W9] 1-(@EXP(-(0.9*B38/$MEAN)^$CPIPES))
D38: [W11] +C38-C37
B39: [W8] 13
C39: [W9] 1-(@EXP(-(0.9*B39/$MEAN)^$CPIPES))
D39: [W11] +C39-C38
B40: [W8] 14
C40: [W9] 1-(@EXP(-(0.9*B40/$MEAN)^$CPIPES))
D40: [W11] +C40-C39
B41: [W8] 15
C41: [W9] 1-(@EXP(-(0.9*B41/$MEAN)^$CPIPES))
D41: [W11] +C41-C40
B42: [W8] 16
C42: [W9] 1-(@EXP(-(0.9*B42/$MEAN)^$CPIPES))
D42: [W11] +C42-C41
B43: [W8] 17
C43: [W9] 1-(@EXP(-(0.9*B43/$MEAN)^$CPIPES))
D43: [W11] +C43-C42
B44: [W8] 18
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C44: [W9] 1-(@EXP(-(0.9*B44/$MEAN)^$CPIPES))
D44: [W11] +C44-C43
B45: [W8] 19
C45: [W9] 1-(@EXP(-(0.9*B45/$MEAN)^$CPIPES))
D45: [W11] +C45-C44
B46: [W8] 20
C46: [W9] 1-(@EXP(-(0.9*B46/$MEAN)^$CPIPES))
D46: [W11] +C46-C45
B47: [W8] 21
C47: [W9] 1-(@EXP(-(0.9*B47/$MEAN)^$CPIPES))
D47: [W11] +C47-C46
B48: [W8] 22
C48: [W9] 1-(@EXP(-(0.9*B48/$MEAN)^$CPIPES))
D48: [W11] +C48-C47
B49: [W8] 23
C49: [W9] 1-(@EXP(-(0.9*B49/$MEAN)^$CPIPES))
D49: [W11] +C49-C48
B50: [W8] 24
C50: [W9] 1-(@EXP(-(0.9*B50/$MEAN)^$CPIPES))
D50: [W11] +C50-C49
B51: [W8] 25
C51: [W9] 1-(@EXP(-(0.9*B51/$MEAN)^$CPIPES))
D51: [W11] +C51-C50
B52: [W8] 26
C52: [W9] 1-(@EXP(-(0.9*B52/$MEAN)^$CPIPES))
D52: [W11] +C52-C51
B53: [W8] 27
C53: [W9] 1-(@EXP(-(0.9*B53/$MEAN)^$CPIPES))
D53: [W11] +C53-C52
B54: [W8] 28
C54: [W9] 1-(@EXP(-(0.9*B54/$MEAN)^$CPIPES))
D54: [W11] +C54-C53
B55: [W8] 29
C55: [W9] 1-(@EXP(-(0.9*B55/$MEAN)^$CPIPES))
D55: [W11] +C55-C54
B56: [W8] 30
C56: [W9] 1-(@EXP(-(0.9*B56/$MEAN)^$CPIPES))
D56: [W11] +C56-C55
B57: [W8] 31
C57: [W9] 1-(@EXP(-(0.9*B57/$MEAN)^$CPIPES))
D57: [W11] +C57-C56
B58: [W8] 32
C58: [W9] 1-(@EXP(-(0.9*B58/$MEAN)^$CPIPES))
D58: [W11] +C58-C57
B59: [W8] 33
C59: [W9] 1-(@EXP(-(0.9*B59/$MEAN)^$CPIPES))
D59: [W11] +C59-C58
B60: [W8] 34
C60: [W9] 1-(@EXP(-(0.9*B60/$MEAN)^$CPIPES))
D60: [W11] +C60-C59
B61: [W8] 35
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C61: [W9] 1-(@EXP(-(0.9*B61/$MEAN)^$CPIPES))
D61: [W11] +C61-C60
B62: [W8] 36
C62: [W9] 1-(@EXP(-(0.9*B62/$MEAN)^$CPIPES))
D62: [W11] +C62-C61
B63: [W8] 37
C63: [W9] 1-(@EXP(-(0.9*B63/$MEAN)^$CPIPES))
D63: [W11] +C63-C62
B64: [W8] 38
C64: [W9] 1-(@EXP(-(0.9*B64/$MEAN)^$CPIPES))
D64: [W11] +C64-C63
B65: [W8] 39
C65: [W9] 1-(@EXP(-(0.9*B65/$MEAN)^$CPIPES))
D65: [W11] +C65-C64
B66: [W8] 40
C66: [W9] 1-(@EXP(-(0.9*B66/$MEAN)^$CPIPES))
D66: [W11] +C66-C65
B67: [W8] 41
C67: [W9] 1-(@EXP(-(0.9*B67/$MEAN)^$CPIPES))
D67: [W11] +C67-C66
B68: [W8] 42
C68: [W9] 1-(@EXP(-(0.9*B68/$MEAN)^$CPIPES))
D68: [W11] +C68-C67
B69: [W8] 43
C69: [W9] 1-(@EXP(-(0.9*B69/$MEAN)^$CPIPES))
D69: [W11] +C69-C68
B70: [W8] 44
C70: [W9] 1-(@EXP(-(0.9*B70/$MEAN)^$CPIPES))
D70: [W11] +C70-C69
B71: [W8] 45
C71: [W9] 1-(@EXP(-(0.9*B71/$MEAN)^$CPIPES))
D71: [W11] +C71-C70
B72: [W8] 46
C72: [W9] 1-(@EXP(-(0.9*B72/$MEAN)^$CPIPES))
D72: [W11] +C72-C71
B73: [W8] 47
C73: [W9] 1-(@EXP(-(0.9*B73/$MEAN)^$CPIPES))
D73: [W11] +C73-C72
B74: [W8] 48
C74: [W9] 1-(@EXP(-(0.9*B74/$MEAN)^$CPIPES))
D74: [W11] +C74-C73
B75: [W8] 49
C75: [W9] 1-(@EXP(-(0.9*B75/$MEAN)^$CPIPES))
D75: [W11] +C75-C74
B76: [W8] 50
C76: [W9] 1-(@EXP(-(0.9*B76/$MEAN)^$CPIPES))
D76: [W11] +C76-C75
B77: [W8] 51
C77: [W9] 1-(@EXP(-(0.9*B77/$MEAN)^$CPIPES))
D77: [W11] +C77-C76
B78: [W8] 52
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C78: [W9] 1-(@EXP(-(0.9*B78/$MEAN)^$CPIPES))
D78: [W11] +C78-C77
B79: [W8] 53
C79: [W9] 1-(@EXP(-(0.9*B79/$MEAN)^$CPIPES))
D79: [W11] +C79-C78
B80: [W8] 54
C80: [W9] 1-(@EXP(-(0.9*B80/$MEAN)^$CPIPES))
D80: [W11] +C80-C79
B81: [W8] 55
C81: [W9] 1-(@EXP(-(0.9*B81/$MEAN)^$CPIPES))
D81: [W11] +C81-C80
B82: [W8] 56
C82: [W9] 1-(@EXP(-(0.9*B82/$MEAN)^$CPIPES))
D82: [W11] +C82-C81
B83: [W8] 57
C83: [W9] 1-(@EXP(-(0.9*B83/$MEAN)^$CPIPES))
D83: [W11] +C83-C82
B84: [W8] 58
C84: [W9] 1-(@EXP(-(0.9*B84/$MEAN)^$CPIPES))
D84: [W11] +C84-C83
B85: [W8] 59
C85: [W9] 1-(@EXP(-(0.9*B85/$MEAN)^$CPIPES))
D85: [W11] +C85-C84
B86: [W8] 60
C86: [W9] 1-(@EXP(-(0.9*B86/$MEAN)^$CPIPES))
D86: [W11] +C86-C85
B87: [W8] 61
C87: [W9] 1-(@EXP(-(0.9*B87/$MEAN)^$CPIPES))
D87: [W11] +C87-C86
B88: [W8] 62
C88: [W9] 1-(@EXP(-(0.9*B88/$MEAN)^$CPIPES))
D88: [W11] +C88-C87
B89: [W8] 63
C89: [W9] 1-(@EXP(-(0.9*B89/$MEAN)^$CPIPES))
D89: [W11] +C89-C88
B90: [W8] 64
C90: [W9] 1-(@EXP(-(0.9*B90/$MEAN)^$CPIPES))
D90: [W11] +C90-C89
B91: [W8] 65
C91: [W9] 1-(@EXP(-(0.9*B91/$MEAN)^$CPIPES))
D91: [W11] +C91-C90
B92: [W8] 66
C92: [W9] 1-(@EXP(-(0.9*B92/$MEAN)^$CPIPES))
D92: [W11] +C92-C91
B93: [W8] 67
C93: [W9] 1-(@EXP(-(0.9*B93/$MEAN)^$CPIPES))
D93: [W11] +C93-C92
B94: [W8] 68
C94: [W9] 1-(@EXP(-(0.9*B94/$MEAN)^$CPIPES))
D94: [W11] +C94-C93
B95: [W8] 69
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C95: [W9] 1-(@EXP(-(0.9*B95/$MEAN)^$CPIPES))
D95: [W11] +C95-C94
B96: [W8] 70
C96: [W9] 1-(@EXP(-(0.9*B96/$MEAN)^$CPIPES))
D96: [W11] +C96-C95
B97: [W8] 71
C97: [W9] 1-(@EXP(-(0.9*B97/$MEAN)^$CPIPES))
D97: [W11] +C97-C96
B98: [W8] 72
C98: [W9] 1-(@EXP(-(0.9*B98/$MEAN)^$CPIPES))
D98: [W11] +C98-C97
B99: [W8] 73
C99: [W9] 1-(@EXP(-(0.9*B99/$MEAN)^$CPIPES))
D99: [W11] +C99-C98
B100: [W8] 74
C100: [W9] 1-(@EXP(-(0.9*B100/$MEAN)^$CPIPES))
D100: [W11] +C100-C99
B101: [W8] 75
C101: [W9] 1-(@EXP(-(0.9*B101/$MEAN)^$CPIPES))
D101: [W11] +C101-C100
B102: [W8] 76
C102: [W9] 1-(@EXP(-(0.9*B102/$MEAN)^$CPIPES))
D102: [W11] +C102-C101
B103: [W8] 77
C103: [W9] 1-(@EXP(-(0.9*B103/$MEAN)^$CPIPES))
D103: [W11] +C103-C102
B104: [W8] 78
C104: [W9] 1-(@EXP(-(0.9*B104/$MEAN)^$CPIPES))
D104: [W11] +C104-C103
B105: [W8] 79
C105: [W9] 1-(@EXP(-(0.9*B105/$MEAN)^$CPIPES))
D105: [W11] +C105-C104
B106: [W8] 80
C106: [W9] 1-(@EXP(-(0.9*B106/$MEAN)^$CPIPES))
D106: [W11] +C106-C105
B107: [W8] 81
C107: [W9] 1-(@EXP(-(0.9*B107/$MEAN)^$CPIPES))
D107: [W11] +C107-C106
B108: [W8] 82
C108: [W9] 1-(@EXP(-(0.9*B108/$MEAN)^$CPIPES))
D108: [W11] +C108-C107
B109: [W8] 83
C109: [W9] 1-(@EXP(-(0.9*B109/$MEAN)^$CPIPES))
D109: [W11] +C109-C108
B110: [W8] 84
C110: [W9] 1-(@EXP(-(0.9*B110/$MEAN)^$CPIPES))
D110: [W11] +C110-C109
B111: [W8] 85
C111: [W9] 1-(@EXP(-(0.9*B111/$MEAN)^$CPIPES))
D111: [W11] +C111-C110
B112: [W8] 86
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C112: [W9] 1-(@EXP(-(0.9*B112/$MEAN)^$CPIPES))
D112: [W11] +C112-C111
B113: [W8] 87
C113: [W9] 1-(@EXP(-(0.9*B113/$MEAN)^$CPIPES))
D113: [W11] +C113-C112
B114: [W8] 88
C114: [W9] 1-(@EXP(-(0.9*B114/$MEAN)^$CPIPES))
D114: [W11] +C114-C113
B115: [W8] 89
C115: [W9] 1-(@EXP(-(0.9*B115/$MEAN)^$CPIPES))
D115: [W11] +C115-C114
B116: [W8] 90
C116: [W9] 1-(@EXP(-(0.9*B116/$MEAN)^$CPIPES))
D116: [W11] +C116-C115
B117: [W8] 91
C117: [W9] 1-(@EXP(-(0.9*B117/$MEAN)^$CPIPES))
D117: [W11] +C117-C116
B118: [W8] 92
C118: [W9] 1-(@EXP(-(0.9*B118/$MEAN)^$CPIPES))
D118: [W11] +C118-C117
B119: [W8] 93
C119: [W9] 1-(@EXP(-(0.9*B119/$MEAN)^$CPIPES))
D119: [W11] +C119-C118
B120: [W8] 94
C120: [W9] 1-(@EXP(-(0.9*B120/$MEAN)^$CPIPES))
D120: [W11] +C120-C119
B121: [W8] 95
C121: [W9] 1-(@EXP(-(0.9*B121/$MEAN)^$CPIPES))
D121: [W11] +C121-C120
B122: [W8] 96
C122: [W9] 1-(@EXP(-(0.9*B122/$MEAN)^$CPIPES))
D122: [W11] +C122-C121
B123: [W8] 97
C123: [W9] 1-(@EXP(-(0.9*B123/$MEAN)^$CPIPES))
D123: [W11] +C123-C122
B124: [W8] 98
C124: [W9] 1-(@EXP(-(0.9*B124/$MEAN)^$CPIPES))
D124: [W11] +C124-C123
B125: [W8] 99
C125: [W9] 1-(@EXP(-(0.9*B125/$MEAN)^$CPIPES))
D125: [W11] +C125-C124
B126: [W8] 100
C126: [W9] 1-(@EXP(-(0.9*B126/$MEAN)^$CPIPES))
D126: [W11] +C126-C125
D128: [W11] '
B129: [W8] 'CALCULATION OF PDV OF COST OF REPLACEMENT OF PIPES
C131: [W9] '
D131: [W11] '
C132: [W9] ^TOTAL PDV
D132: [W11] ^SURVIVING
E132: [W11] ^DISCOUNT
```

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F132: [W10] ^PIPES
G132: [W8] ^REPLAC.
B133: [W8] "YEARS
C133: [W9] ^COST
D133: [W11] ^HOUSES
E133: [W11] ^FACTOR
F133: [W10] ^REPLACED
G133: [W8] ^COST
B134: [W8] 1
C134: [W9] +D134*E134*(F134*G134)
D134: [W11] (@EXP(-(0.9*B134/$HOME)^$CHOUSES))
E134: [W11] (1/((1+$IR)^(B134)))
F134: [W10] @SUM(D27..CY27)
G134: [W8] ($RLCOS*(($INFL+1)^B134))
B135: [W8] 2
C135: [W9] +D135*E135*(F135*G135)
D135: [W11] (@EXP(-(0.9*B135/$HOME)^$CHOUSES))
E135: [W11] (1/((1+$IR)^(B135)))
F135: [W10] @SUM(D28..CY28)
G135: [W8] ($RLCOS*(($INFL+1)^B135))
B136: [W8] 3
C136: [W9] +D136*E136*(F136*G136)
D136: [W11] (@EXP(-(0.9*B136/$HOME)^$CHOUSES))
E136: [W11] (1/((1+$IR)^(B136)))
F136: [W10] @SUM(D29..CY29)
G136: [W8] ($RLCOS*(($INFL+1)^B136))
B137: [W8] 4
C137: [W9] +D137*E137*(F137*G137)
D137: [W11] (@EXP(-(0.9*B137/$HOME)^$CHOUSES))
E137: [W11] (1/((1+$IR)^(B137)))
F137: [W10] @SUM(D30..CY30)
G137: [W8] ($RLCOS*(($INFL+1)^B137))
B138: [W8] 5
C138: [W9] +D138*E138*(F138*G138)
D138: [W11] (@EXP(-(0.9*B138/$HOME)^$CHOUSES))
E138: [W11] (1/((1+$IR)^(B138)))
F138: [W10] @SUM(D31..CY31)
G138: [W8] ($RLCOS*(($INFL+1)^B138))
B139: [W8] 6
C139: [W9] +D139*E139*(F139*G139)
D139: [W11] (@EXP(-(0.9*B139/$HOME)^$CHOUSES))
E139: [W11] (1/((1+$IR)^(B139)))
F139: [W10] @SUM(D32..CY32)
G139: [W8] ($RLCOS*(($INFL+1)^B139))
B140: [W8] 7
C140: [W9] +D140*E140*(F140*G140)
D140: [W11] (@EXP(-(0.9*B140/$HOME)^$CHOUSES))
E140: [W11] (1/((1+$IR)^(B140)))
F140: [W10] @SUM(D33..CY33)
G140: [W8] ($RLCOS*(($INFL+1)^B140))
B141: [W8] 8
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C141: [W9] +D141*E141*(F141*G141)
D141: [W11] (@EXP(-(0.9*B141/$HOME)^$CHOUSES))
E141: [W11] (1/((1+$IR)^(B141)))
F141: [W10] @SUM(D34..CY34)
G141: [W8] ($RLCOS*(($INFL+1)^B141))
B142: [W8] 9
C142: [W9] +D142*E142*(F142*G142)
D142: [W11] (@EXP(-(0.9*B142/$HOME)^$CHOUSES))
E142: [W11] (1/((1+$IR)^(B142)))
F142: [W10] @SUM(D35..CY35)
G142: [W8] ($RLCOS*(($INFL+1)^B142))
B143: [W8] 10
C143: [W9] +D143*E143*(F143*G143)
D143: [W11] (@EXP(-(0.9*B143/$HOME)^$CHOUSES))
E143: [W11] (1/((1+$IR)^(B143)))
F143: [W10] @SUM(D36..CY36)
G143: [W8] ($RLCOS*(($INFL+1)^B143))
B144: [W8] 11
C144: [W9] +D144*E144*(F144*G144)
D144: [W11] (@EXP(-(0.9*B144/$HOME)^$CHOUSES))
E144: [W11] (1/((1+$IR)^(B144)))
F144: [W10] @SUM(D37..CY37)
G144: [W8] ($RLCOS*(($INFL+1)^B144))
B145: [W8] 12
C145: [W9] +D145*E145*(F145*G145)
D145: [W11] (@EXP(-(0.9*B145/$HOME)^$CHOUSES))
E145: [W11] (1/((1+$IR)^(B145)))
F145: [W10] @SUM(D38..CY38)
G145: [W8] ($RLCOS*(($INFL+1)^B145))
B146: [W8] 13
C146: [W9] +D146*E146*(F146*G146)
D146: [W11] (@EXP(-(0.9*B146/$HOME)^$CHOUSES))
E146: [W11] (1/((1+$IR)^(B146)))
F146: [W10] @SUM(D39..CY39)
G146: [W8] ($RLCOS*(($INFL+1)^B146))
B147: [W8] 14
C147: [W9] +D147*E147*(F147*G147)
D147: [W11] (@EXP(-(0.9*B147/$HOME)^$CHOUSES))
E147: [W11] (1/((1+$IR)^(B147)))
F147: [W10] @SUM(D40..CY40)
G147: [W8] ($RLCOS*(($INFL+1)^B147))
B148: [W8] 15
C148: [W9] +D148*E148*(F148*G148)
D148: [W11] (@EXP(-(0.9*B148/$HOME)^$CHOUSES))
E148: [W11] (1/((1+$IR)^(B148)))
F148: [W10] @SUM(D41..CY41)
G148: [W8] ($RLCOS*(($INFL+1)^B148))
B149: [W8] 16
C149: [W9] +D149*E149*(F149*G149)
D149: [W11] (@EXP(-(0.9*B149/$HOME)^$CHOUSES))
E149: [W11] (1/((1+$IR)^(B149)))
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F149: [W10] @SUM(D42..CY42)
G149: [W8] ($RLCOS*(($INFL+1)^B149))
B150: [W8] 17
C150: [W9] +D150*E150*(F150*G150)
D150: [W11] (@EXP(-(0.9*B150/$HOME)^$CHOUSES))
E150: [W11] (1/((1+$IR)^(B150)))
F150: [W10] @SUM(D43..CY43)
G150: [W8] ($RLCOS*(($INFL+1)^B150))
B151: [W8] 18
C151: [W9] +D151*E151*(F151*G151)
D151: [W11] (@EXP(-(0.9*B151/$HOME)^$CHOUSES))
E151: [W11] (1/((1+$IR)^(B151)))
F151: [W10] @SUM(D44..CY44)
G151: [W8] ($RLCOS*(($INFL+1)^B151))
B152: [W8] 19
C152: [W9] +D152*E152*(F152*G152)
D152: [W11] (@EXP(-(0.9*B152/$HOME)^$CHOUSES))
E152: [W11] (1/((1+$IR)^(B152)))
F152: [W10] @SUM(D45..CY45)
G152: [W8] ($RLCOS*(($INFL+1)^B152))
B153: [W8] 20
C153: [W9] +D153*E153*(F153*G153)
D153: [W11] (@EXP(-(0.9*B153/$HOME)^$CHOUSES))
E153: [W11] (1/((1+$IR)^(B153)))
F153: [W10] @SUM(D46..CY46)
G153: [W8] ($RLCOS*(($INFL+1)^B153))
B154: [W8] 21
C154: [W9] +D154*E154*(F154*G154)
D154: [W11] (@EXP(-(0.9*B154/$HOME)^$CHOUSES))
E154: [W11] (1/((1+$IR)^(B154)))
F154: [W10] @SUM(D47..CY47)
G154: [W8] ($RLCOS*(($INFL+1)^B154))
B155: [W8] 22
C155: [W9] +D155*E155*(F155*G155)
D155: [W11] (@EXP(-(0.9*B155/$HOME)^$CHOUSES))
E155: [W11] (1/((1+$IR)^(B155)))
F155: [W10] @SUM(D48..CY48)
G155: [W8] ($RLCOS*(($INFL+1)^B155))
B156: [W8] 23
C156: [W9] +D156*E156*(F156*G156)
D156: [W11] (@EXP(-(0.9*B156/$HOME)^$CHOUSES))
E156: [W11] (1/((1+$IR)^(B156)))
F156: [W10] @SUM(D49..CY49)
G156: [W8] ($RLCOS*(($INFL+1)^B156))
B157: [W8] 24
C157: [W9] +D157*E157*(F157*G157)
D157: [W11] (@EXP(-(0.9*B157/$HOME)^$CHOUSES))
E157: [W11] (1/((1+$IR)^(B157)))
F157: [W10] @SUM(D50..CY50)
G157: [W8] ($RLCOS*(($INFL+1)^B157))
B158: [W8] 25
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C158: [W9] +D158*E158*(F158*G158)
D158: [W11] (@EXP(-(0.9*B158/$HOME)^$CHOUSES))
E158: [W11] (1/((1+$IR)^(B158)))
F158: [W10] @SUM(D51..CY51)
G158: [W8] ($RLCOS*(($INFL+1)^B158))
B159: [W8] 26
C159: [W9] +D159*E159*(F159*G159)
D159: [W11] (@EXP(-(0.9*B159/$HOME)^$CHOUSES))
E159: [W11] (1/((1+$IR)^(B159)))
F159: [W10] @SUM(D52..CY52)
G159: [W8] ($RLCOS*(($INFL+1)^B159))
B160: [W8] 27
C160: [W9] +D160*E160*(F160*G160)
D160: [W11] (@EXP(-(0.9*B160/$HOME)^$CHOUSES))
E160: [W11] (1/((1+$IR)^(B160)))
F160: [W10] @SUM(D53..CY53)
G160: [W8] ($RLCOS*(($INFL+1)^B160))
B161: [W8] 28
C161: [W9] +D161*E161*(F161*G161)
D161: [W11] (@EXP(-(0.9*B161/$HOME)^$CHOUSES))
E161: [W11] (1/((1+$IR)^(B161)))
F161: [W10] @SUM(D54..CY54)
G161: [W8] ($RLCOS*(($INFL+1)^B161))
B162: [W8] 29
C162: [W9] +D162*E162*(F162*G162)
D162: [W11] (@EXP(-(0.9*B162/$HOME)^$CHOUSES))
E162: [W11] (1/((1+$IR)^(B162)))
F162: [W10] @SUM(D55..CY55)
G162: [W8] ($RLCOS*(($INFL+1)^B162))
B163: [W8] 30
C163: [W9] +D163*E163*(F163*G163)
D163: [W11] (@EXP(-(0.9*B163/$HOME)^$CHOUSES))
E163: [W11] (1/((1+$IR)^(B163)))
F163: [W10] @SUM(D56..CY56)
G163: [W8] ($RLCOS*(($INFL+1)^B163))
B164: [W8] 31
C164: [W9] +D164*E164*(F164*G164)
D164: [W11] (@EXP(-(0.9*B164/$HOME)^$CHOUSES))
E164: [W11] (1/((1+$IR)^(B164)))
F164: [W10] @SUM(D57..CY57)
G164: [W8] ($RLCOS*(($INFL+1)^B164))
B165: [W8] 32
C165: [W9] +D165*E165*(F165*G165)
D165: [W11] (@EXP(-(0.9*B165/$HOME)^$CHOUSES))
E165: [W11] (1/((1+$IR)^(B165)))
F165: [W10] @SUM(D58..CY58)
G165: [W8] ($RLCOS*(($INFL+1)^B165))
B166: [W8] 33
C166: [W9] +D166*E166*(F166*G166)
D166: [W11] (@EXP(-(0.9*B166/$HOME)^$CHOUSES))
E166: [W11] (1/((1+$IR)^(B166)))
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F166: [W10] @SUM(D59..CY59)
G166: [W8] ($RLCOS*(($INFL+1)^B166))
B167: [W8] 34
C167: [W9] +D167*E167*(F167*G167)
D167: [W11] (@EXP(-(0.9*B167/$HOME)^$CHOUSES))
E167: [W11] (1/((1+$IR)^(B167)))
F167: [W10] @SUM(D60..CY60)
G167: [W8] ($RLCOS*(($INFL+1)^B167))
B168: [W8] 35
C168: [W9] +D168*E168*(F168*G168)
D168: [W11] (@EXP(-(0.9*B168/$HOME)^$CHOUSES))
E168: [W11] (1/((1+$IR)^(B168)))
F168: [W10] @SUM(D61..CY61)
G168: [W8] ($RLCOS*(($INFL+1)^B168))
B169: [W8] 36
C169: [W9] +D169*E169*(F169*G169)
D169: [W11] (@EXP(-(0.9*B169/$HOME)^$CHOUSES))
E169: [W11] (1/((1+$IR)^(B169)))
F169: [W10] @SUM(D62..CY62)
G169: [W8] ($RLCOS*(($INFL+1)^B169))
B170: [W8] 37
C170: [W9] +D170*E170*(F170*G170)
D170: [W11] (@EXP(-(0.9*B170/$HOME)^$CHOUSES))
E170: [W11] (1/((1+$IR)^(B170)))
F170: [W10] @SUM(D63..CY63)
G170: [W8] ($RLCOS*(($INFL+1)^B170))
B171: [W8] 38
C171: [W9] +D171*E171*(F171*G171)
D171: [W11] (@EXP(-(0.9*B171/$HOME)^$CHOUSES))
E171: [W11] (1/((1+$IR)^(B171)))
F171: [W10] @SUM(D64..CY64)
G171: [W8] ($RLCOS*(($INFL+1)^B171))
B172: [W8] 39
C172: [W9] +D172*E172*(F172*G172)
D172: [W11] (@EXP(-(0.9*B172/$HOME)^$CHOUSES))
E172: [W11] (1/((1+$IR)^(B172)))
F172: [W10] @SUM(D65..CY65)
G172: [W8] ($RLCOS*(($INFL+1)^B172))
B173: [W8] 40
C173: [W9] +D173*E173*(F173*G173)
D173: [W11] (@EXP(-(0.9*B173/$HOME)^$CHOUSES))
E173: [W11] (1/((1+$IR)^(B173)))
F173: [W10] @SUM(D66..CY66)
G173: [W8] ($RLCOS*(($INFL+1)^B173))
B174: [W8] 41
C174: [W9] +D174*E174*(F174*G174)
D174: [W11] (@EXP(-(0.9*B174/$HOME)^$CHOUSES))
E174: [W11] (1/((1+$IR)^(B174)))
F174: [W10] @SUM(D67..CY67)
G174: [W8] ($RLCOS*(($INFL+1)^B174))
B175: [W8] 42
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C175: [W9] +D175*E175*(F175*G175)
D175: [W11] (@EXP(-(0.9*B175/$HOME)^$CHOUSES))
E175: [W11] (1/((1+$IR)^(B175)))
F175: [W10] @SUM(D68..CY68)
G175: [W8] ($RLCOS*(($INFL+1)^B175))
B176: [W8] 43
C176: [W9] +D176*E176*(F176*G176)
D176: [W11] (@EXP(-(0.9*B176/$HOME)^$CHOUSES))
E176: [W11] (1/((1+$IR)^(B176)))
F176: [W10] @SUM(D69..CY69)
G176: [W8] ($RLCOS*(($INFL+1)^B176))
B177: [W8] 44
C177: [W9] +D177*E177*(F177*G177)
D177: [W11] (@EXP(-(0.9*B177/$HOME)^$CHOUSES))
E177: [W11] (1/((1+$IR)^(B177)))
F177: [W10] @SUM(D70..CY70)
G177: [W8] ($RLCOS*(($INFL+1)^B177))
B178: [W8] 45
C178: [W9] +D178*E178*(F178*G178)
D178: [W11] (@EXP(-(0.9*B178/$HOME)^$CHOUSES))
E178: [W11] (1/((1+$IR)^(B178)))
F178: [W10] @SUM(D71..CY71)
G178: [W8] ($RLCOS*(($INFL+1)^B178))
B179: [W8] 46
C179: [W9] +D179*E179*(F179*G179)
D179: [W11] (@EXP(-(0.9*B179/$HOME)^$CHOUSES))
E179: [W11] (1/((1+$IR)^(B179)))
F179: [W10] @SUM(D72..CY72)
G179: [W8] ($RLCOS*(($INFL+1)^B179))
B180: [W8] 47
C180: [W9] +D180*E180*(F180*G180)
D180: [W11] (@EXP(-(0.9*B180/$HOME)^$CHOUSES))
E180: [W11] (1/((1+$IR)^(B180)))
F180: [W10] @SUM(D73..CY73)
G180: [W8] ($RLCOS*(($INFL+1)^B180))
B181: [W8] 48
C181: [W9] +D181*E181*(F181*G181)
D181: [W11] (@EXP(-(0.9*B181/$HOME)^$CHOUSES))
E181: [W11] (1/((1+$IR)^(B181)))
F181: [W10] @SUM(D74..CY74)
G181: [W8] ($RLCOS*(($INFL+1)^B181))
B182: [W8] 49
C182: [W9] +D182*E182*(F182*G182)
D182: [W11] (@EXP(-(0.9*B182/$HOME)^$CHOUSES))
E182: [W11] (1/((1+$IR)^(B182)))
F182: [W10] @SUM(D75..CY75)
G182: [W8] ($RLCOS*(($INFL+1)^B182))
B183: [W8] 50
C183: [W9] +D183*E183*(F183*G183)
D183: [W11] (@EXP(-(0.9*B183/$HOME)^$CHOUSES))
E183: [W11] (1/((1+$IR)^(B183)))
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F183: [W10] @SUM(D76..CY76)
G183: [W8] ($RLCOS*(($INFL+1)^B183))
B184: [W8] 51
C184: [W9] +D184*E184*(F184*G184)
D184: [W11] (@EXP(-(0.9*B184/$HOME)^$CHOUSES))
E184: [W11] (1/((1+$IR)^(B184)))
F184: [W10] @SUM(D77..CY77)
G184: [W8] ($RLCOS*(($INFL+1)^B184))
B185: [W8] 52
C185: [W9] +D185*E185*(F185*G185)
D185: [W11] (@EXP(-(0.9*B185/$HOME)^$CHOUSES))
E185: [W11] (1/((1+$IR)^(B185)))
F185: [W10] @SUM(D78..CY78)
G185: [W8] ($RLCOS*(($INFL+1)^B185))
B186: [W8] 53
C186: [W9] +D186*E186*(F186*G186)
D186: [W11] (@EXP(-(0.9*B186/$HOME)^$CHOUSES))
E186: [W11] (1/((1+$IR)^(B186)))
F186: [W10] @SUM(D79..CY79)
G186: [W8] ($RLCOS*(($INFL+1)^B186))
B187: [W8] 54
C187: [W9] +D187*E187*(F187*G187)
D187: [W11] (@EXP(-(0.9*B187/$HOME)^$CHOUSES))
E187: [W11] (1/((1+$IR)^(B187)))
F187: [W10] @SUM(D80..CY80)
G187: [W8] ($RLCOS*(($INFL+1)^B187))
B188: [W8] 55
C188: [W9] +D188*E188*(F188*G188)
D188: [W11] (@EXP(-(0.9*B188/$HOME)^$CHOUSES))
E188: [W11] (1/((1+$IR)^(B188)))
F188: [W10] @SUM(D81..CY81)
G188: [W8] ($RLCOS*(($INFL+1)^B188))
B189: [W8] 56
C189: [W9] +D189*E189*(F189*G189)
D189: [W11] (@EXP(-(0.9*B189/$HOME)^$CHOUSES))
E189: [W11] (1/((1+$IR)^(B189)))
F189: [W10] @SUM(D82..CY82)
G189: [W8] ($RLCOS*(($INFL+1)^B189))
B190: [W8] 57
C190: [W9] +D190*E190*(F190*G190)
D190: [W11] (@EXP(-(0.9*B190/$HOME)^$CHOUSES))
E190: [W11] (1/((1+$IR)^(B190)))
F190: [W10] @SUM(D83..CY83)
G190: [W8] ($RLCOS*(($INFL+1)^B190))
B191: [W8] 58
C191: [W9] +D191*E191*(F191*G191)
D191: [W11] (@EXP(-(0.9*B191/$HOME)^$CHOUSES))
E191: [W11] (1/((1+$IR)^(B191)))
F191: [W10] @SUM(D84..CY84)
G191: [W8] ($RLCOS*(($INFL+1)^B191))
B192: [W8] 59
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C192: [W9] +D192*E192*(F192*G192)
D192: [W11] (@EXP(-(0.9*B192/$HOME)^$CHOUSES))
E192: [W11] (1/((1+$IR)^(B192)))
F192: [W10] @SUM(D85..CY85)
G192: [W8] ($RLCOS*(($INFL+1)^B192))
B193: [W8] 60
C193: [W9] +D193*E193*(F193*G193)
D193: [W11] (@EXP(-(0.9*B193/$HOME)^$CHOUSES))
E193: [W11] (1/((1+$IR)^(B193)))
F193: [W10] @SUM(D86..CY86)
G193: [W8] ($RLCOS*(($INFL+1)^B193))
B194: [W8] 61
C194: [W9] +D194*E194*(F194*G194)
D194: [W11] (@EXP(-(0.9*B194/$HOME)^$CHOUSES))
E194: [W11] (1/((1+$IR)^(B194)))
F194: [W10] @SUM(D87..CY87)
G194: [W8] ($RLCOS*(($INFL+1)^B194))
B195: [W8] 62
C195: [W9] +D195*E195*(F195*G195)
D195: [W11] (@EXP(-(0.9*B195/$HOME)^$CHOUSES))
E195: [W11] (1/((1+$IR)^(B195)))
F195: [W10] @SUM(D88..CY88)
G195: [W8] ($RLCOS*(($INFL+1)^B195))
B196: [W8] 63
C196: [W9] +D196*E196*(F196*G196)
D196: [W11] (@EXP(-(0.9*B196/$HOME)^$CHOUSES))
E196: [W11] (1/((1+$IR)^(B196)))
F196: [W10] @SUM(D89..CY89)
G196: [W8] ($RLCOS*(($INFL+1)^B196))
B197: [W8] 64
C197: [W9] +D197*E197*(F197*G197)
D197: [W11] (@EXP(-(0.9*B197/$HOME)^$CHOUSES))
E197: [W11] (1/((1+$IR)^(B197)))
F197: [W10] @SUM(D90..CY90)
G197: [W8] ($RLCOS*(($INFL+1)^B197))
B198: [W8] 65
C198: [W9] +D198*E198*(F198*G198)
D198: [W11] (@EXP(-(0.9*B198/$HOME)^$CHOUSES))
E198: [W11] (1/((1+$IR)^(B198)))
F198: [W10] @SUM(D91..CY91)
G198: [W8] ($RLCOS*(($INFL+1)^B198))
B199: [W8] 66
C199: [W9] +D199*E199*(F199*G199)
D199: [W11] (@EXP(-(0.9*B199/$HOME)^$CHOUSES))
E199: [W11] (1/((1+$IR)^(B199)))
F199: [W10] @SUM(D92..CY92)
G199: [W8] ($RLCOS*(($INFL+1)^B199))
B200: [W8] 67
C200: [W9] +D200*E200*(F200*G200)
D200: [W11] (@EXP(-(0.9*B200/$HOME)^$CHOUSES))
E200: [W11] (1/((1+$IR)^(B200)))
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F200: [W10] @SUM(D93..CY93)
G200: [W8] ($RLCOS*(($INFL+1)^B200))
B201: [W8] 68
C201: [W9] +D201*E201*(F201*G201)
D201: [W11] (@EXP(-(0.9*B201/$HOME)^$CHOUSES))
E201: [W11] (1/((1+$IR)^(B201)))
F201: [W10] @SUM(D94..CY94)
G201: [W8] ($RLCOS*(($INFL+1)^B201))
B202: [W8] 69
C202: [W9] +D202*E202*(F202*G202)
D202: [W11] (@EXP(-(0.9*B202/$HOME)^$CHOUSES))
E202: [W11] (1/((1+$IR)^(B202)))
F202: [W10] @SUM(D95..CY95)
G202: [W8] ($RLCOS*(($INFL+1)^B202))
B203: [W8] 70
C203: [W9] +D203*E203*(F203*G203)
D203: [W11] (@EXP(-(0.9*B203/$HOME)^$CHOUSES))
E203: [W11] (1/((1+$IR)^(B203)))
F203: [W10] @SUM(D96..CY96)
G203: [W8] ($RLCOS*(($INFL+1)^B203))
B204: [W8] 71
C204: [W9] +D204*E204*(F204*G204)
D204: [W11] (@EXP(-(0.9*B204/$HOME)^$CHOUSES))
E204: [W11] (1/((1+$IR)^(B204)))
F204: [W10] @SUM(D97..CY97)
G204: [W8] ($RLCOS*(($INFL+1)^B204))
B205: [W8] 72
C205: [W9] +D205*E205*(F205*G205)
D205: [W11] (@EXP(-(0.9*B205/$HOME)^$CHOUSES))
E205: [W11] (1/((1+$IR)^(B205)))
F205: [W10] @SUM(D98..CY98)
G205: [W8] ($RLCOS*(($INFL+1)^B205))
B206: [W8] 73
C206: [W9] +D206*E206*(F206*G206)
D206: [W11] (@EXP(-(0.9*B206/$HOME)^$CHOUSES))
E206: [W11] (1/((1+$IR)^(B206)))
F206: [W10] @SUM(D99..CY99)
G206: [W8] ($RLCOS*(($INFL+1)^B206))
B207: [W8] 74
C207: [W9] +D207*E207*(F207*G207)
D207: [W11] (@EXP(-(0.9*B207/$HOME)^$CHOUSES))
E207: [W11] (1/((1+$IR)^(B207)))
F207: [W10] @SUM(D100..CY100)
G207: [W8] ($RLCOS*(($INFL+1)^B207))
B208: [W8] 75
C208: [W9] +D208*E208*(F208*G208)
D208: [W11] (@EXP(-(0.9*B208/$HOME)^$CHOUSES))
E208: [W11] (1/((1+$IR)^(B208)))
F208: [W10] @SUM(D101..CY101)
G208: [W8] ($RLCOS*(($INFL+1)^B208))
B209: [W8] 76
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C209: [W9] +D209*E209*(F209*G209)
D209: [W11] (@EXP(-(0.9*B209/$HOME)^$CHOUSES))
E209: [W11] (1/((1+$IR)^(B209)))
F209: [W10] @SUM(D102..CY102)
G209: [W8] ($RLCOS*(($INFL+1)^B209))
B210: [W8] 77
C210: [W9] +D210*E210*(F210*G210)
D210: [W11] (@EXP(-(0.9*B210/$HOME)^$CHOUSES))
E210: [W11] (1/((1+$IR)^(B210)))
F210: [W10] @SUM(D103..CY103)
G210: [W8] ($RLCOS*(($INFL+1)^B210))
B211: [W8] 78
C211: [W9] +D211*E211*(F211*G211)
D211: [W11] (@EXP(-(0.9*B211/$HOME)^$CHOUSES))
E211: [W11] (1/((1+$IR)^(B211)))
F211: [W10] @SUM(D104..CY104)
G211: [W8] ($RLCOS*(($INFL+1)^B211))
B212: [W8] 79
C212: [W9] +D212*E212*(F212*G212)
D212: [W11] (@EXP(-(0.9*B212/$HOME)^$CHOUSES))
E212: [W11] (1/((1+$IR)^(B212)))
F212: [W10] @SUM(D105..CY105)
G212: [W8] ($RLCOS*(($INFL+1)^B212))
B213: [W8] 80
C213: [W9] +D213*E213*(F213*G213)
D213: [W11] (@EXP(-(0.9*B213/$HOME)^$CHOUSES))
E213: [W11] (1/((1+$IR)^(B213)))
F213: [W10] @SUM(D106..CY106)
G213: [W8] ($RLCOS*(($INFL+1)^B213))
B214: [W8] 81
C214: [W9] +D214*E214*(F214*G214)
D214: [W11] (@EXP(-(0.9*B214/$HOME)^$CHOUSES))
E214: [W11] (1/((1+$IR)^(B214)))
F214: [W10] @SUM(D107..CY107)
G214: [W8] ($RLCOS*(($INFL+1)^B214))
B215: [W8] 82
C215: [W9] +D215*E215*(F215*G215)
D215: [W11] (@EXP(-(0.9*B215/$HOME)^$CHOUSES))
E215: [W11] (1/((1+$IR)^(B215)))
F215: [W10] @SUM(D108..CY108)
G215: [W8] ($RLCOS*(($INFL+1)^B215))
B216: [W8] 83
C216: [W9] +D216*E216*(F216*G216)
D216: [W11] (@EXP(-(0.9*B216/$HOME)^$CHOUSES))
E216: [W11] (1/((1+$IR)^(B216)))
F216: [W10] @SUM(D109..CY109)
G216: [W8] ($RLCOS*(($INFL+1)^B216))
B217: [W8] 84
C217: [W9] +D217*E217*(F217*G217)
D217: [W11] (@EXP(-(0.9*B217/$HOME)^$CHOUSES))
E217: [W11] (1/((1+$IR)^(B217)))
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F217: [W10] @SUM(D110..CY110)
G217: [W8] ($RLCOS*(($INFL+1)^B217))
B218: [W8] 85
C218: [W9] +D218*E218*(F218*G218)
D218: [W11] (@EXP(-(0.9*B218/$HOME)^$CHOUSES))
E218: [W11] (1/((1+$IR)^(B218)))
F218: [W10] @SUM(D111..CY111)
G218: [W8] ($RLCOS*(($INFL+1)^B218))
B219: [W8] 86
C219: [W9] +D219*E219*(F219*G219)
D219: [W11] (@EXP(-(0.9*B219/$HOME)^$CHOUSES))
E219: [W11] (1/((1+$IR)^(B219)))
F219: [W10] @SUM(D112..CY112)
G219: [W8] ($RLCOS*(($INFL+1)^B219))
B220: [W8] 87
C220: [W9] +D220*E220*(F220*G220)
D220: [W11] (@EXP(-(0.9*B220/$HOME)^$CHOUSES))
E220: [W11] (1/((1+$IR)^(B220)))
F220: [W10] @SUM(D113..CY113)
G220: [W8] ($RLCOS*(($INFL+1)^B220))
B221: [W8] 88
C221: [W9] +D221*E221*(F221*G221)
D221: [W11] (@EXP(-(0.9*B221/$HOME)^$CHOUSES))
E221: [W11] (1/((1+$IR)^(B221)))
F221: [W10] @SUM(D114..CY114)
G221: [W8] ($RLCOS*(($INFL+1)^B221))
B222: [W8] 89
C222: [W9] +D222*E222*(F222*G222)
D222: [W11] (@EXP(-(0.9*B222/$HOME)^$CHOUSES))
E222: [W11] (1/((1+$IR)^(B222)))
F222: [W10] @SUM(D115..CY115)
G222: [W8] ($RLCOS*(($INFL+1)^B222))
B223: [W8] 90
C223: [W9] +D223*E223*(F223*G223)
D223: [W11] (@EXP(-(0.9*B223/$HOME)^$CHOUSES))
E223: [W11] (1/((1+$IR)^(B223)))
F223: [W10] @SUM(D116..CY116)
G223: [W8] ($RLCOS*(($INFL+1)^B223))
B224: [W8] 91
C224: [W9] +D224*E224*(F224*G224)
D224: [W11] (@EXP(-(0.9*B224/$HOME)^$CHOUSES))
E224: [W11] (1/((1+$IR)^(B224)))
F224: [W10] @SUM(D117..CY117)
G224: [W8] ($RLCOS*(($INFL+1)^B224))
B225: [W8] 92
C225: [W9] +D225*E225*(F225*G225)
D225: [W11] (@EXP(-(0.9*B225/$HOME)^$CHOUSES))
E225: [W11] (1/((1+$IR)^(B225)))
F225: [W10] @SUM(D118..CY118)
G225: [W8] ($RLCOS*(($INFL+1)^B225))
B226: [W8] 93
```

```
C226: [W9] +D226*E226*(F226*G226)
D226: [W11] (@EXP(-(0.9*B226/$HOME)^$CHOUSES))
E226: [W11] (1/((1+$IR)^(B226)))
F226: [W10] @SUM(D119..CY119)
G226: [W8] ($RLCOS*(($INFL+1)^B226))
B227: [W8] 94
C227: [W9] +D227*E227*(F227*G227)
D227: [W11] (@EXP(-(0.9*B227/$HOME)^$CHOUSES))
E227: [W11] (1/((1+$IR)^(B227)))
F227: [W10] @SUM(D120..CY120)
G227: [W8] ($RLCOS*(($INFL+1)^B227))
B228: [W8] 95
C228: [W9] +D228*E228*(F228*G228)
D228: [W11] (@EXP(-(0.9*B228/$HOME)^$CHOUSES))
E228: [W11] (1/((1+$IR)^(B228)))
F228: [W10] @SUM(D121..CY121)
G228: [W8] ($RLCOS*(($INFL+1)^B228))
B229: [W8] 96
C229: [W9] +D229*E229*(F229*G229)
D229: [W11] (@EXP(-(0.9*B229/$HOME)^$CHOUSES))
E229: [W11] (1/((1+$IR)^(B229)))
F229: [W10] @SUM(D122..CY122)
G229: [W8] ($RLCOS*(($INFL+1)^B229))
B230: [W8] 97
C230: [W9] +D230*E230*(F230*G230)
D230: [W11] (@EXP(-(0.9*B230/$HOME)^$CHOUSES))
E230: [W11] (1/((1+$IR)^(B230)))
F230: [W10] @SUM(D123..CY123)
G230: [W8] ($RLCOS*(($INFL+1)^B230))
B231: [W8] 98
C231: [W9] +D231*E231*(F231*G231)
D231: [W11] (@EXP(-(0.9*B231/$HOME)^$CHOUSES))
E231: [W11] (1/((1+$IR)^(B231)))
F231: [W10] @SUM(D124..CY124)
G231: [W8] ($RLCOS*(($INFL+1)^B231))
B232: [W8] 99
C232: [W9] +D232*E232*(F232*G232)
D232: [W11] (@EXP(-(0.9*B232/$HOME)^$CHOUSES))
E232: [W11] (1/((1+$IR)^(B232)))
F232: [W10] @SUM(D125..CY125)
G232: [W8] ($RLCOS*(($INFL+1)^B232))
B233: [W8] 100
C233: [W9] +D233*E233*(F233*G233)
D233: [W11] (@EXP(-(0.9*B233/$HOME)^$CHOUSES))
E233: [W11] (1/((1+$IR)^(B233)))
F233: [W10] @SUM(D126..CY126)
G233: [W8] ($RLCOS*(($INFL+1)^B233))
B235: [W8] "TOTAL
C235: [W9] @SUM(C233..C134)
F235: [W10] '
```

Appendix D

Analysis of the Repair Costs of Copper and Plastic Systems

The first table below presents the cost of repairs assumed in Kirmeyer (1983) and updates it to 1989 dollars.

Cost of Repairs From Kirmeyer (1983)

(1) Item (all 1982$):	(2) Cost per Unit	(3) Number	(4) (2)x(3)
Pipe Repair	$75.00	2	$150.00
Repair Leak and Damage	$250.00	1	$250.00
		Total	$400.00
	Total (1989$)		$475.06

Next we compute the present value of these repairs. Kirmeyer et. al. assume that all repairs will take place in the last 10 years of life of a plumbing system. Putting all the costs in the middle year of this period gives a conservative estimate of the present value of the costs. The future costs are projected on the basis of present costs and the construction cost index from Means (1988). Future costs are discounted using the three month treasury bill rate and fixed rate mortgage rate as bounds.

Present Value of Repair Costs

	3 month Treasury Bills	FHA Mortgages
Present Value at		
15 year horizon (plastic pipe)	$393.13	$247.10
59 year horizon (copper pipe)	$225.62	$36.32
difference	$167.51	$210.78

(Note: All calculations assume that construction price inflation will continue at the average rate of the last 20 years (6.25%). Interest rates are averages for last

20 years.)

Appendix E

List of Municipalities Surveyed

Albany

Berkeley

El Cerito

San Francisco

San Leandro

Appendix F

Calgary Herald, September 28, 1989

G

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT G

Thomas Reid Associates, "Material Cost Comparison: CPVC vs. Copper Plumbing" August 21, 1998

Material Cost Comparison: CPVC vs. Copper Plumbing

CPVC	Quantity *	Unit Cost **	Total Cost
10 ft pipe 1/2"	16.5	$3.49	57.59
10 ft pipe 3/4"	13.4	$5.49	73.57
elbow 1/2" 90 deg	43	$0.19	8.17
elbow 3/4" 90 deg	26	$0.39	10.14
elbow, 45 deg, 1/2"	6	$0.25	1.50
elbow, 45 deg, 3/4"	1	$0.25	0.25
Tee 1/2"	3	$0.25	0.75
Tee 3/4"	14	$0.59	8.26
Cement 4 oz.	4	$2.59	10.36
Cement 8 oz.	4	$3.99	15.96
		Total Cost of CPVC	**$187**
COPPER			
10 ft pipe 1/2" (Type M)	16.5	$4.49	74.09
10 ft pipe 3/4"	13.4	$7.30	97.82
elbow, 90 deg, 1/2"	43	$0.29	12.47
elbow, 90 deg, 3/4"	26	$0.65	16.90
elbow, 45 deg, 1/2"	6	$0.59	3.54
elbow, 45 deg, 3/4"	1	$0.99	0.99
Tee ½"	3	$0.49	1.47
Tee 3/4"	14	$0.99	13.86
Solder, ½ lb.	4	$5.69	22.76
		Total Cost of Copper	**$244**
		CPVC Saving	**$57**
		CPVC cost as a percentage of Copper	**76%**

* Amount of Pipe Suggested by Dickens,1989

** Prices from Orchard Supply Hardware May 1997

August 21, 1998 G:\L\LPPC\econanal.wb2

H

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT H

Inside Cal/EPA "EPA Region IX Poised to Reverse Water Board Decision on Dioxin" July 10, 1998

EPA REGION IX POISED TO REVERSE WATER BOARD DECISION ON DIOXIN

U.S. EPA Region IX is expected to reverse the water board's decision not to list dioxin as a high priority pollutant for the San Francisco Bay under the Clean Water Act, however the action will not occur soon given that the agency received the list just two weeks ago.

Environmentalists, who engineered an emergency resolution on the matter by the National Environmental Justice Advisory Council to EPA last month, have requested a meeting with Region IX Administrator Felicia Marcus and confirmation from Region IX about the decision. Sources are already indicating that the reversal is a given, although it is unclear what priority for action Region IX will set for dioxin.

Region IX staffers are reviewing the Water Resources Control Board's proposed list of impaired waters under the Clean Water Act, which was due April 1. The delay in submitting the proposal occurred when the WRCB, "at the 11th hour," decided to hold a public hearing on proposed changes to the listing, including the addition of dioxin as a pollutant of the bay.

"Most likely, we will partially approve and disapprove the list," said a Region IX source. "If we determine that dioxin should be on the list, we would disapprove the [WRCB], offer a proposal and invite public comment through a *Federal Register* notice."

analysis or state/federal water quality criteria applicable to the south bay, of which none exist now, according to the source. "My view is that no one has been saying that the cities should do an action that they refuse to do," said the source. "In that sense, I thought that part of the process seemed to have worked. What didn't work was how do we put that into a permit."

BayKeeper supports a zero-effluent limitation for dioxin, stating in its letter that "a region-wide and, ultimately, statewide prohibition on dioxin discharges is the only regulatory position that would assure thorough efforts are made to reduce and, eventually, eliminate the diverse sources of this highly dangerous pollutant."

The regional board has made "some progress" in slowing the amount of copper and nickel to the bay and "we can't start backsliding," said the BayKeeper source. The metals arrive from upstream sources, rainwater infiltration and via the copper sulfate that is used to clean sewer pipes, said the source. Despite the work being done to compile TMDL analyses, environmentalists stress that regulatory issues be kept "squarely on the table" while ensuring that dischargers receive legal permits. BayKeeper is also considering whether to challenge the permits on the grounds that only monitoring requirements exist for organics, polychlorinated biphenyls and pesticides.

"Sewage plants are obvious sources and to not have them in the permit is not a good idea," said the source.

Rather than establishing detection limits for certain chemicals that are nearly impossible to achieve, the regional board decided to use those figures as goals with the requirement that cities conduct surveys to determine the sources of those materials, said the regional board source. The WRCB could decide to uphold the permits, change them, which seldom occurs, or remand them to the regional board with or without instruction.

CIWMB FEARS FALLOUT FROM HAZ-WASTE REG PLAN . . . continued from page 1

The CIWMB resolution has not been thoroughly reviewed by DTSC, said a spokesman, who added that the board "is entitled to their perspective." DTSC remains on schedule to soon conclude California Environmental Quality Act comment on the proposal, which is based on the "best scientific knowledge available," said the source.

The waste classification proposal is a two-tier hazardous waste system derived from the federal toxicity characteristic leaching procedure that determines whether a waste is hazardous depending on solubility thresholds. Under the plan, the amount of fully hazardous waste disposed annually in the most stringently guarded landfills (Class I) would be reduced from 574,353 tons to 236,337 tons annually, while approximately 127,689 tons of nonhazardous waste disposed annually would become fully hazardous waste and "special waste."

Of particular concern to the CIWMB are DTSC estimates that the amount of hazardous waste that will qualify as special waste suitable for landfill disposal will jump from 5,743 tons to 341,242 tons annually. DTSC has not provided the CIWMB with any estimates for the amount of fully hazardous waste currently disposed annually in Class II/III landfills through variances, although indications are that the amount is small.

"The increase in Special Waste . . . would be a significant increase in the volume of waste eligible for disposal via a variance in a Class II/III landfill," according to the CIWMB. "The impact of this increase would be even more significant if only a few solid waste landfills were to receive a variance."

The process used by DTSC to issue disposal variances is "unclear," according to CIWMB staff, which indicates that the practice of issuing variances from DTSC's headquarters could switch to regional office issuance. Staff says that interagency communication has been absent as "it appears that [regional water boards and local enforcement agencies] and DTSC do not currently collaborate in the determination of what fully

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT I

Thomas Reid Associates, "Solvent Content of Cement and Primer Comparison" August 21, 1998

Solvent Content of Cement and Primer Comparison

Source/ Product	THF	MEK	CHX	ACE
Cements				
Butter (1986)[1] IPS Weld-On	55%	10%	7.4%	0.3%
Cooper (1987)[2] Master Plumber Cement	major	major	minor	neg.
Cooper (1987) [2] Ace Cement	major	major	minor	neg.
Bellows (1989) tested cements [3]	65.9 -85.4%	0-14.1%	6.7-12.3%	not reported as present
MSDS (1997)XX cement - IPS Low VOC[4,5]	not indicated on MSDS	20%	not indicated on MSDS	not reported as present
MSDS (1997) cement - Oatey Low VOC[4]	40-50%	<5%	5-10%	24-35%
TRI (1998) cement - Oatey Low VOC[4,5]	60%	<5%	10%	20%
TRI (1998) cement - IPS Low VOC[4,5]	45%	30%	25%	<5%
Anresco (1996) cement - Oatey Low VOC[4,7]	not measured	not measured	not measured	25.25%
Primers				
Butter (1986)[1] IPS Primer P-72	100% (sic)	2.7%	0.1%	0
Cooper (1987) [2] Master Plumber Primer	minor	major	minor	neg.
Cooper (1987) [2] Ace Pipe Cleaner	neg.	minor	neg.	100%
Bellows (1989) tested primers [3]	28-80%	0-37.5%	0-10%	0-55%
MSDS (1997) primer - IPS Low VOC[4]	15-55%	27-37%	5-30%	25-35%
MSDS (1997) primer - Oatey Low VOC[4]	10-15%	70-80%	12-16%	1-5%
TRI (1998) primer - Oatey Low VOC[4,5]	5%	75%	20%	<5%
TRI (1998) primer - IPS Low VOC[4,5]	50%	40%	10%	<5%
Anresco (1996) primer - Oatey Low VOC[4,7]	not measured	not measured	not measured	<0.001%

Notes:

MSDS = Material Safety Data Sheet

THF = Tetrahydrofuran, MEK = Methylethylketone, CHX = Cychlohexanone, ACE = Acetone

neg. Negligible

1) Butter, G.N., Marshall, P.G., Steele, W., and Bankert K.E. 1986. "Effects on Water Quality by Leachable Substances from Copper Tubing, CPVC Piping and Galvanized Pipe Fittings," Study conducted for the Vinyl Institute by McKesson Environmental Services, Inc., Pleasanton, CA. HCD-128. Part III, Table 3.

2) Cooper, R.C., et al. 1987. "Plastic Pipe Leaching Study," Sanitary Engineering and Environmental Health Research Laboratory Report No. 87-11, University of California, Berkeley. HCD-125. Accurex Lab conducted extractant water tests of solvent primer and cement (excerpts attached). Accurex reported some bulk content and other constituents can be inferred.

3) Bellows, et al. 1989. "Plastic Pipe Installation: Potential Health Hazards for Workers." California Department of Health Services. Only the CPVC-pw (potable water) products were used from Bellows study Appendix E. The ingredients of one of the primers in Bellows study included 7.5% DMF.

4) Only NSF 14/NSF 61 Low VOC potable water approved products from Oatey & IPS were used.

5) TRI results based on actual testing of Oatey and IPS cements and primers Aug. 7, 1998, see Thomas Reid Associates Attachment R, 1998 Testing Results, TRI/Environmental, Inc.

6) IPS manufactures other CPVC cements for industrial applications, not approved by NSF for potable water, that contain 50-70% THF.

7) Anresco results based on actual testing of VOC exempt content of Oatey Orange LO-VOC CPVC Cement and Oatey LO-VOC Purple Primer, June 1996, reported to Thomas Reid Associates

APPENDIX I

received
5-18-87

ACUREX Corporation

Environmental Systems Division

UC Berkeley
1301 So. 46Th Street
Richmond, CA 94804

May 15, 1987
Acurex ID#: 8703013/8703035
Client PO#: 7-477529-TR
Page 1 of 13

Attention: Dr. Robert Cooper

Subject: Revised Report on the Extraction and Analysis of Ten Samples for Volatile Organic Compounds and Priority Pollutant Metals.

The room temperature and high temperature (60°C) extractions of the two CPVC cements and pipe primers and cleaners were conducted according to the protocol and our discussions. Twenty grams of material was weigned out into an amber bottle and 500 mL of water was added. Additional water was added to bring the liquid to the top of the bottle (no headspace) and the teflon lined cap was screwed on. Final volume of water was 513-520 mL (534 mL for the blank). The samples were extracted for 72 hours with constant agitation provided by a stirring bar. At the conclusion of the extraction, the bottles were opened and two 40 mL VOA vials were filled. The remainder of the sample was subdivided witn 200 mL for metals analysis and 200 mL for semivolatile organic extraction. The non-VOA water was filtered prior to being subdivided.

The water samples were analyzed for volatile organic compounds according to EPA Method 624 (Federal Register, Volume 49 No. 209, Oct. 26, 1984; Page 141) except that the purgeable organic compounds were introduced into the gas chromatograph by direct injection after being diluted due to the high levels of non-priority pollutant volatile compounds that were present. Because of the high levels of acetone, MEK, tetrahydrofuran (THF) and cyclohexanone that were present, the initial run did not provide a clear picture of trace materials that were present. To better assess this, the high temperature samples were rerun, but the high peaks were "diverted". This gave lower detection limits. Results are presented in Tables 1-2 (room temperature) and Tables 3-4 (high temperature). Tables 3-4 reflect a combination of the two different runs, with the more accurate results reported.

A special calibration curve was prepared that contained acetone, 2-butanone (methyl ethyl ketone) and tetrahydrofuran (THF). The method results in quantitation is accurate to about +/-20%. The Ace pipe cleaner is almost 100% acetone. The Master plumber primer is mainly MEK. None of the samples from either temperature contain any priority pollutants. The high temperature extraction resulted in measureable cyclohexanone, a major semivolatile cement component. The diversion technique, while it lowered detection limits, only resulted in two additional unknown peaks being found in one sample.

Qualitative identification of the priority pollutants is performed initially using the relative retention times, and the relative abundance of three unique ions. The entire mass spectrum is checked before any final identifications are recorded. Quantitative analysis is performed by the internal standard method using a single characteristic ion and response factors obtained from a daily calibration standard. In the tables, an entry such as "<5" means that the compound is not detected and the detection limit is 5.

Prior to analysis, every sample is spiked with surrogate compounds as part of Acurex's Quality Control Program. These compounds simulate the behavior of compounds of interest and confirm that acceptable recoveries are being achieved on every sample. However, the high concentrations of the compounds found, resulted in the surrogates being diluted out. Surrogates were not spiked into the diverted samples.

Samples were analyzed for requested metals using atomic absorption spectrometry following Methods for Chemical Analysis of Water and Wastes (EPA 1983). The EPA method which was employed is listed along the side of the parameter. Where the method ends in ".1" (except 245.1), the sample was digested in nitric and hydrochloric acids, aspirated into a flame, and atomized. Where the method ends in ".2," the sample was digested in nitric acid, hydrochloric acid added when specified by the EPA method, placed on a stabilized temperature graphite platform, electrothermally heated, and atomized. Nickel nitrate was added in the determination of arsenic and selenium to prevent loss of the analyte. Mercury was determined by the cold vapor technique, where the mercury in the sample was reduced to the elemental state and the mercury vapor purged. The atoms were placed in the light path of an atomic absorption spectrometer where the absorbance of light specific to the element of interest was measured. The atomic absorption spectrometer was run in the dual beam mode with deuterium background correction where it was possible so as to minimize interferences. The results are presented in Table 4.

If you should have any questions, please do not hesitate to call.

Sincerely yours,

David R. Taylor, Ph.D.
Project Manager

RS/DRT/jn
cc: M. McMillan

These results were obtained by following standard laboratory procedures; the liability of Acurex Corporation shall not exceed the amount paid for this report. In no event shall Acurex be liable for special or consequential damages.

Table 4. Other Identified Compounds

U.C. Berkeley High Temperature Samples

Volatile Compounds	Ace Pipe Cleaner mg/L	Ace Cement mg/L	Master Plumber Primer mg/L	Master Plumber Cement mg/L	Blank mg/L
Acetone	44000	<250	<210	<176	<250
2-Butanone	2900	12000	26000	12000	<250
Tetrahydrofuran	<250	15000	1800	16000	<250
Cyclohexanone	<90	4600	5000	4700	<250

Table 2. Tentatively Identified Compounds

UC Berkeley Room Temperature Samples

Volatile Compounds	Ace Pipe Cleaner mg/L	Ace Cement mg/L	Master Plumber Primer mg/L	Master Plumber Cement mg/L	Blank mg/L
Acetone	41000	<25	150	120	<5
2-Butanone	1600	12000	33000	15000	<5
Tetrahydrofuran	<250	13000	2500	17000	<5

These compounds have been quantitated by a separate analysis after calibrating with a fresh standard of the above three compounds.

J

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT J

Ron Coiner Deposition, BF Goodrich vs. Village in the Lake in the Hills, Sept. 3, 1997

In The Matter Of:

The B.F. Goodrich Company v.
Lake in the Hills, Illinois, et al.

Ronald M. Coiner
September 3, 1997

McCorkle Court Reporters, Inc.
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STATE OF ILLINOIS)
) SS:
COUNTY OFCOOK)
IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS; EASTERN DIVISION
THE B.F. GOODRICH COMPANY,)
a New York Corporation,)
Plaintiff,)
vs.) No. 96 C 50346
LAKE IN THE HILLS, ILLINOIS,)
a Municipality of the)
State of Illinois,)
and DAVID SELLEK,)
Building Commissioner for)
Lake in the Hills,)
Defendants.)

The discovery deposition of RONALD M. COINER, taken in the above-entitled cause, before Nicole S. Nero, a notary public of Cook County, Illinois, on the 3rd day of September, 1997 at 100 South Wacker Drive, Chicago, Illinois, pursuant to Notice.
Reported by: Nicole S. Nero, CSR
License No.: 084-004233

Page 1

APPEARANCES:
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Representing the Defendant.

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By MS. CYZE	133
By MR. GORDON	136

EXHIBITS

NUMBER	MARKED FOR ID
COINER Deposition Exhibit	
Nos. 1-3	4
Nos. 4-5	109

Page 3

(Whereupon, COINER Deposition Exhibit Nos. 1-3 were marked for identification.)

(Witness sworn.)

RONALD COINER,

called as a witness herein, having been first duly sworn, was examined and testified as follows:

EXAMINATION

BY MR. GORDON:

Q: Could you state your name for the record, please?

A: Ronald M. Coiner.

Q: My name is Stuart Gordon and I represent Lake in the Hills and David Sellek in a lawsuit brought by B.F. Goodrich. I will be asking you a series of questions today. Have you ever been deposed before?

A: Yes.

Q: Okay. Then perhaps you know from your last deposition that I will need verbal answers like yes or no or explanations rather than uh-uh or uh-huh or the nod of your head.

A: Yes.

Q: Sometimes my questions don't make much

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sense even to me, if my question or a question doesn't make sense to you just tell me and I will rephrase it so you do understand. If you need a break during the course of the deposition let me know and we'll take a break, okay.

Where do you reside, sir?

A: Ann Arbor, Michigan.

Q: And how long have you lived there?

A: Since September 1993.

Q: And your business address?

A: 3475 Plymouth Road, Ann Arbor, Michigan.

Q: And the name of your business?

A: NSF International.

Q: And how long have you been with NSF?

A: Since August 1987.

Q: Where did you graduate from high school?

A: Western Gilford.

Q: In what city?

A: Greenburo, North Carolina.

Q: In what year?

A: 1980.

Q: And upon graduating from high school did you go to college?

A: Yes.

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Q: And where did you attend college?

A: Western Carolina University.

Q: And did you receive a degree there?

A: Yes.

Q: And that was a BS?

A: A BS in environment.

Q: And what year was that?

A: 1985.

Q: Is that a five-year program?

A: That is a four-year program.

Q: Were you in school all five years?

A: Yes.

Q: Can you describe for me what the study of environment health includes?

A: It includes courses in the sciences, chemistry, biology, geology as well as classes in entomology, water born disease control, food born disease control.

Q: While you were a student at Western Carolina University did you take any courses that included the study of CPVC?

A: No.

Q: Do you know what is used in the manufacturing of CPVC pipe.

Page 6

A: Yes.

Q: Did you take any courses that included the study of those particular components or compounds?

A: No.

Q: Did you take any courses concerning the chemicals that are used in the solvent cement used for joining CPVC pipes and fittings?

A: No.

Q: Did you take any courses concerning the materials used in formulating any type of cleaner that is used in the installation of CPVC pipes and fittings?

A: No.

Q: Since graduating from Western Carolina University in 1985 have you had any additional formal education, by formal I mean have you returned to any colleges or universities for different additional courses?

A: No.

Q: As part of your employment have you had informal educational courses, seminars?

A: I am not clear on the description between formal and informal.

Q: Okay. I was trying to draw the distinction

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so that formal would mean you go to a regular university take a regular course for a certain period of time as opposed to perhaps an industry sponsored seminar or meeting where you attend classes ranging from a matter of hours to perhaps a day or two?

A: Okay. I still – well, I still have a question about the difference between formal and informal. The example that you gave for informal is rather narrow if it's restricted to industry sponsored.

Q: All right. You don't have to restrict it to industry sponsored, I am looking for some kind of education at that time that doesn't have a mascot for its football team how's that?

A: Okay. Yes. I have received additional training.

Q: Okay. And what type of additional training would that be?

A: Additional training relative to pub-

lic[21] health and additional training relative to NSF [22] standards and the plastic piping industry, the [23] plastic piping product specifically.

[24] **Q:** Okay. In the first category relative to

Page 8

[1] public health what training would that have been?

[2] **A:** That would be the training required to [3] become a registered sanitarian in the State of [4] North Carolina.

[5] **Q:** Okay. And where did you receive that [6] training?

[7] **A:** In the State of North Carolina.

[8] **Q:** Can you be a little more specific?

[9] **A:** The locations varied.

[10] **Q:** Where were these courses located?

[11] **A:** In Cabarrus County.

[12] **Q:** Who provided these?

[13] **A:** The State of North Carolina.

[14] **Q:** Were you employed by a governmental entity [15] at that time?

[16] **A:** Yes.

[17] **Q:** And was that part of the training that was [18] offered to people in your position?

[19] **A:** That was part of the required training for [20] people in my position, yes.

[21] **Q:** And what governmental entity were you [22] employed by?

[23] **A:** Cabarrus County Health Department.

[24] **Q:** Do you remember the nature of the courses

Page 9

[1] that you took to become a registered sanitarian?

[2] **A:** They were food protection, groundwater, [3] plumbing systems, wastewater disposal systems.

[4] **Q:** With respect to plumbing systems what type [5] of courses did you have?

[6] **A:** They were general in nature, my [7] recollection is that they were revolved around the [8] state's regulations.

[9] **Q:** Now, in terms of plumbing are we talking [10] about wastewater?

[11] **A:** My focus was wastewater.

[12] **Q:** Did any of those courses concern potable [13] water?

[14] **A:** That I don't recall specifically.

[15] **Q:** As you sit here today you can't recall any [16] courses dealing with potable water?

[17] **A:** I don't really recall if the State of [18] North Carolina specifically addressed potable [19] water.

[20] **Q:** Is there a way that we can quantify the [21] number of courses that you took to become a [22] registered sanitarian?

[23] **A:** I don't know.

[24] **Q:** Let me back up, over how long a period of

Page 10

[1] time – strike that.

[2] When did you become a registered [3] sanitarian?

[4] **A:** Approximately 1986, and that is an [5] approximation.

[6] **Q:** Okay. I don't think that this case will [7] turn on whether it was '85 or '87, how long had you [8] been with the county when you became a registered [9] sanitarian?

[10] **A:** I was with the Cabarrus County Health [11] Department for approximately two years.

[12] **Q:** Before you became a registered sanitarian?

[13] **A:** Yes. Before becoming a registered [14] sanitarian.

[15] **Q:** Okay. You already told me that you had [16] additional training relative to NSF standards in [17] plastic piping product where was that training?

[18] **A:** That would have been at NSF.

[19] **Q:** While you were employed at NSF?

[20] **A:** Yes. And additionally in my course work at [21] Western Carolina University I did have classes in [22] which the NSF standards were discussed and used. I [23] also used the NSF standards in my capacity with the [24] Cabarrus County Health Department.

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[1] **Q:** I understand that, I am talking about the [2] NSF training was all that training that you [3] received while an NSF employee?

[4] **A:** No.

[5] **Q:** Okay. While you were with – prior to [6] joining NSF did you receive any training in NSF [7] standards with respect to plastic piping products?

[8] **A:** Yes.

[9] **Q:** And what was that training?

[10] **A:** I believe the course title was [11] recreational water or recreational water [12] management.

[13] **Q:** Are we talking about swimming pools here?

[14] **A:** That particular one did deal with that.

[15] **Q:** The standards there specifically addressed [16] commercial and residential pool construction and it [17] did not deal with potable water?

[18] **A:** Actually most people think of water that [19] you swim in as a type of potable water from the [20] public health view.

[21] **Q:** That's certainly true, but you could not [22] drink it, it's not potable water?

[23] **A:** You wouldn't necessarily drink swimming [24] pool water either unless you wanted a mouth full of

Page 12

[1] algae. Certainly I don't think anyone would [2] internally ingest pool water however when you swim [3] you do ingest some quantity of water.

[4] **Q:** Rather then play some game of semantics [5] when I use the term potable water I mean the type [6] of water that you get out of your fountain and [7] you're going to drink it. I understand that you [8] can put it other places, but I am not interested in [9] the other places.

[10] **A:** Okay. Additionally I do recall another [11] class and it was a course on housing again at [12] Western Carolina University, and in that course we [13] did have discussions on potable water piping [14] systems and wastewater systems in a structure.

[15] **Q:** Did either of those courses involve CPVC [16] products?

[17] **A:** I don't recall.

[18] **Q:** At NSF have you had training specifically [19] speaking with respect to CPVC products including [20] pipes and solvents?

[21] **A:** Yes.

[22] **Q:** And can you tell me what that training [23] included?

[24] **A:** It included the review of the recognized

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[1] product standards, review of the NSF standards, [2] review of the NSF certification requirements, and [3] review of the national plumbing codes with respect [4] to various products including CPVC.

[5] **Q:** Did you receive any training in the proper [6] installation of CPVC products?

[7] **A:** I am not involved in the installation of [8] those products so the answer would have to be no.

[9] **Q:** Do you have any knowledge regarding the [10] proper method for installing CPVC potable water [11] distribution systems?

[12] **A:** For clarification are you asking me if I [13] ever installed CPVC?

[14] **Q:** No. I am asking if you ever received any [15] training in the installation?

[16] **A:** I have not received any formal training in [17] the installation of CPVC.

[18] **Q:** Okay. When you qualify an answer with a [19] word that I didn't use that

makes me ask another [20] question, have you received any informal training [21] in CPVC installation?

[22] **A:** I have watched various plumbers over the [23] course of my life and I am sure I have caught a [24] segment or two of This Old House, so from the

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[1] standpoint of the question was do I have knowledge [2] then that's the extent of it.

[3] **Q:** Do you have knowledge as to the proper [4] method for installing a CPVC potable water [5] distribution system?

[6] **A:** Yes.

[7] **Q:** Okay. Does that include knowledge as to [8] the proper method for joining CPVC and the pipe and [9] fittings?

[10] **A:** Yes.

[11] **Q:** And where did you obtain that knowledge?

[12] **A:** Reading the various standards, [13] installation directions, handbooks that have been [14] published.

[15] **Q:** Can you tell me which standards you looked [16] at with respect to proper methods for joining CPVC [17] pipes and fittings?

[18] **A:** I don't recall the references.

[19] **Q:** Was this an NSF standard?

[20] **A:** No. I believe it's actually an ACTM [21] standard that addresses the proper method used to [22] make a joint between a plastic fitting and a [23] plastic pipe.

[24] **Q:** And what do you recall the proper method

Page 15

[1] to be?

[2] **A:** I would have to refer back to the standard [3] specifically and it would also vary depending on [4] the cement based on the manufacturers instructions.

[5] **Q:** Are there some cements that are proper for [6] joining CPVC and some plastic cements that are not [7] proper?

[8] **A:** There are cements that are specifically [9] designed to be used with a CPVC piping system.

[10] **Q:** Are there some cements that are [11] inappropriate for that use?

[12] **MS. CYZE:** I am objecting to this continuous [13] line of installation. Mr. Coiner is not here nor [14] is any way represented to be here as an expert in [15] what's proper and what's not with the joining of [16] CPVC pipes and fittings and cement, and I don't [17] think that you have established a foundation that [18] he is an expert in the joining of CPVC pipes, [19] fittings, and cements.

[20] **MR. GORDON:** Well, I am looking at his opinions [21] and I assume that if he is going to comment on the [22] proper use of solvent cements he knows what the [23] proper use of it is.

[24] I have to say I am having a difficult time

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[1] understanding what his opinions are. I don't know [2] what his opinions are and I am asking him those [3] questions so that I know the basis for his [4] opinions.

[5] In any event you're not instructing him [6] not to answer are you?

[7] **MS. CYZE:** No.

[8] **BY MR. GORDON:**

[9] **Q:** Do you remember the question?

[10] **A:** No.

[11] **MR. GORDON:** Could you read it back, please.

[12] (Whereupon, the record was read.)

[13] **THE WITNESS:** There are cements that are [14] designed to be used with other thermal plastic [15] materials.

[16] **BY MR. GORDON:**

[17] **Q:** That's not my question.

[18] **A:** Then I do not understand.

[19] **Q:** My question is this: Are there other [20] cements that are formulated for joining as you say [21] thermal plastic materials which would be [22] inappropriate for the use in joining CPVC pipes and [23] fittings to be used in a potable water distribution [24] system?

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[1] **A:** Yes.

[2] **Q:** Okay. What are those cements?

[3] **A:** A cement that was intended to join ABS.

[4] **Q:** And what if you used the ABS cement in [5] joining CPCV what would the result be?

[6] **A:** That I don't know other than you would not [7] use that cement.

[8] **Q:** Other than the ASTM standard that you [9] referred to to gain knowledge about joining CPVC [10] pipe and fittings are there any other standards [11] that you have read on that subject?

[12] **A:** I believe that is the only standard that I [13] have read.

[14] **Q:** You also said that you read installation [15] instructions.

[16] **A:** Yes.

[17] **Q:** And can you tell me what installation [18] instructions you read?

[19] **A:** It would be various instructions, various [20] manufacturers, various products.

[21] **Q:** I am just talking about CPVC?

[22] **A:** And the answer would be the same.

[23] **Q:** Okay. Do you remember any of the [24] manufacturers whose installation instructions you

Page 18

[1] read?

[2] **A:** They would be manufacturers that have [3] product certified against ANSI NSF standard 14.

[4] **Q:** Do you remember the names of any of the [5] manufacturers?

[6] **A:** The Oatey company.

[7] **Q:** They make solvent cements don't they?

[8] **A:** Solvent cements.

[9] **Q:** And they have installation instructions?

[10] **A:** They have instructions on their label, [11] yes.

[12] **Q:** Okay. So you read the labels of cans?

[13] **A:** Yes.

[14] **Q:** Okay. Any other manufacturers?

[15] **A:** There are numerous manufacturers, my [16] suggestion – I mean we could take a look at the [17] listing book and go through the public listings for [18] these products.

[19] **Q:** I know we could, I am just – what I have [20] to do today, Mr. Coiner, is find out what is in [21] your head not what is in somebody else's head. So [22] if we sit down and read a book together that's not [23] really going to educate me on what you know. So I [24] am trying to find out what you recall reviewing and

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[1] you told me that you read instructions, [2] installation instructions on cans of solvent [3] cements.

[4] **A:** Cans of solvent cement and handbooks.

[5] **Q:** On Deposition Exhibit 6 is that the type [6] of can that you read?

[7] **A:** It could be, I don't recall specifically [8] what cans I have looked at, what I haven't looked [9] at.

[10] **Q:** I said is that the type?

[11] **A:** In very general terms, yes. I mean it's a [12] standard can.

[13] **Q:** Okay. And you can't recall other [14] installation instructions; is that correct?

[15] **A:** No. I am not an expert in installation.

[16] **Q:** Okay. You also mentioned that you read [17] handbooks to gain knowledge on joining CPVC pipe [18] and fittings do you recall any of those handbooks?

[19] **A:** No, I don't.

[20] **Q:** Other than what we have dis-

cussed so far [21] have you received any additional training or [22] education with respect to joining CPVC pipe and [23] fittings?

[24] **A:** No.

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[1] **Q:** While you were with Cabarrus County what [2] were your job duties and responsibilities?

[3] **A:** I worked in the waste water program, the [4] food protection program. I spent some time as the [5] county milk sanitarian, and I was involved in the [6] groundwater program.

[7] **Q:** Okay. I think that I understand what most [8] of those are, can you tell me what the groundwater [9] program is?

[10] **A:** Sampling groundwater supplies, primarily [11] residential supplies.

[12] **Q:** Private wells?

[13] **A:** Private wells, small community water [14] systems, doing investigations of installations of [15] private wells, community water systems.

[16] **Q:** Anything else?

[17] **A:** No.

[18] **Q:** With respect to inspecting installations [19] was this for licensing purposes?

[20] **A:** That I don't specifically recall whether [21] that was tied specifically to a license or permit.

[22] **Q:** Can you tell me why you were out here [23] doing it then?

[24] **A:** It could have been any number of reasons,

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[1] complaints from the general public, request for [2] investigation by potential property purchasers, [3] lenders, any request from the public.

[4] **Q:** What would your inspection include?

[5] **A:** At that time there were regulations in the [6] State of North Carolina on the proper design and [7] construction of a well or any groundwater supply, [8] it didn't specifically have to be a well.

[9] **Q:** Did your inspection include distribution [10] systems?

[11] **A:** No, it did not.

[12] **Q:** At the time that you were with Cabarrus [13] County did the State of North Carolina allow the [14] use of CPVC pipes and fittings for potable water [15] distribution systems?

[16] **A:** That I don't recall.

[17] **Q:** So then I take it you wouldn't recall [18] whether – strike that.

[19] The focus of your inspection then was [20] primarily geared toward determining whether or not [21] the method by which the water was retrieved from [22] the ground met the North Carolina standards; is [23] that correct?

[24] **A:** That's correct.

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[1] **Q:** You weren't concerned with unless they got [2] it out of the well how they piped it around their [3] houses for instance?

[4] **A:** No. That was outside of my area of [5] expertise.

[6] **Q:** Did you have any other responsibilities [7] while with Cabarrus County other than wastewater, [8] food, milk, and groundwater that you recall?

[9] **A:** Not that I recall.

[10] **Q:** When did you leave your employment with [11] Cabarrus County?

[12] **A:** August 1987.

[13] **Q:** And your reason for leaving?

[14] **A:** Employment with NSF.

[15] **Q:** So it was voluntary that you left?

[16] **A:** Yes.

[17] **Q:** You have been with NSF for ten years now?

[18] **A:** Yes.

[19] **Q:** And has your job description changed?

[20] **A:** Yes.

[21] **Q:** When you first joined NSF what was your [22] job?

[23] **A:** I was an auditor.

[24] **Q:** Okay. Can you tell me what an auditor at

Page 23

[1] NSF does?

[2] **A:** In that capacity I would make unannounced [3] inspections of production facilities that were [4] authorized to produce products certified by NSF.

[5] **Q:** I notice that some of the Oatey cans of [6] solvent cement have an NSF, a circle with NSF [7] printed in the center, as a condition for allowing [8] companies to use the NSF mark do those companies [9] have to agree to allow those unannounced [10] inspections?

[11] **A:** Yes.

[12] **Q:** What type of facility – strike that. [13] How long were you an auditor?

[14] **A:** I was an auditor through mid-September [15] 1993.

[16] **Q:** In the approximate six years that you were [17] an auditor did you inspect any manufacturers of [18] CPVC products?

[19] **A:** Yes.

[20] **Q:** Which ones were those?

[21] **A:** I don't recall specifically.

[22] **Q:** Do you recall any of them?

[23] **A:** I was based in the southern regional [24] office, so it could have potentially have been any

Page 24

[1] of the manufacturers that would have been in the [2] southeast.

[3] **Q:** Where were you based?

[4] **A:** Based in Atlanta.

[5] **Q:** As you sit here today you cannot recall?

[6] **A:** I know there are several that I have been [7] to, specific name of one would probably be Thompson [8] Plastic, and I am really trying to remember who [9] else has production facilities down in that part of [10] the country.

[11] **Q:** What would you inspect when you would go [12] to a CPVC manufacturer?

[13] **A:** The inspection would include a review of [14] the materials that are being used to produce the [15] final product, a review of the production of that [16] final product, a review of the storage and handling [17] practices both of the material being used to [18] extrude the product and the final product itself, a [19] review of quality control or quality assurance [20] procedures and testing, a review of records [21] relating to quality assurance, quality control of [22] the final product, a review of records on the [23] materials that have been purchased to be used in [24] the product, marketing of the product.

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[1] **Q:** Who trained you to do those things?

[2] **A:** NSF.

[3] **Q:** Other than the things that you mentioned [4] for me a little bit earlier with respect to CPVC [5] and that included: Standards, installation [6] instructions, and handbooks, did you receive any [7] additional training with respect to CPVC product [8] manufacturing?

[9] **A:** From NSF, yes.

[10] **Q:** Okay. What would that training have been?

[11] **A:** That training would have been in addition [12] to ASTM training, the NSF standards training, [13] procedures training, actual field training, going [14] out with other NSF personnel on inspections.

[15] **Q:** So this was a type of on-the-job training?

[16] **A:** Basically a training period where you're [17] under the oversight of a senior level person.

[18] **Q:** And how long did that training period [19] last?

[20] A: That I don't recall.

[21] Q: In terms of your auditing functions did [22] that include any auditing the actual installations [23] of CPVC products?

[24] A: No, it did not.

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[1] Q: Does NSF audit CPVC manufacturers who are [2] located outside of the United States?

[3] A: Yes.

[4] Q: Did you ever audit CPVC manufacturers [5] outside of the United States?

[6] A: Yes.

[7] Q: Where was that?

[8] A: Manufacturer in Chile I believe, and [9] manufactured products in the European community and [10] in the far east.

[11] Q: You did those?

[12] A: Yes.

[13] Q: With respect to CPVC products?

[14] A: Yes.

[15] Q: Do you remember the names of those [16] manufacturers?

[17] A: Technicos Hydrophus, please don't ask me [18] to spell it.

[19] Q: Where is it located?

[20] A: Santiago, Chile. In our production [21] location in Poland that I am not recalling – I [22] believe it is Nipko Polaska.

[23] Q: Any others?

[24] A: And the locations in the far east I am not

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[1] sure whether I conducted audits or whether I did [2] just a site visit. Whether that was an inspection [3] or just a site visit – in fact I believe it was a [4] site visit.

[5] Q: Can a manufacturer of CPVC products [6] manufacture and sell those products without an NSF [7] designation?

[8] A: Yes.

[9] Q: And in that case they wouldn't be subject [10] to your auditing; is that correct?

[11] A: That's correct.

[12] Q: In September of 1993 did you receive a new [13] job designation at NSF?

[14] A: Yes.

[15] Q: And what was that?

[16] A: I was promoted from senior field [17] representative to manager of new product [18] certifications.

[19] Q: And were those products in any particular [20] area?

[21] A: Actually in all areas, it was not program [22] specific.

[23] Q: Does this include CPVC products?

[24] A: That would have included CPVC products.

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[1] yes.

[2] Q: In the four years that you have been the [3] manger of new product certifications –

[4] A: That's not my current position.

[5] Q: How long were you in this job?

[6] A: I was in that position until June of 1994, [7] so not quite a year.

[8] Q: In your nine months that you were the [9] manager of new product certifications did you [10] certify or work on the certification of any CPCV [11] products?

[12] A: It's very probably, I don't remember [13] specifically.

[14] Q: What would the certification process have [15] involved with respect to a new CPVC product?

[16] A: It would include product information [17] symatal, based on that information we would [18] determine the certification requirements for the [19] particular product whether it's a pipe, a fitting [20] what have you. And those could include physical [21] property, testing of the base material being used. [22] They could include testing of the pipe or fitting [23] against the performance standard from an [24] organization like ASTM that the product has been

Page 29

[1] designed around. It would include a health effects [2] evaluation against the requirements of ANSI NSF [3] standard 61, including chemical extraction of [4] representative product, initial plant inspection.

[5] Q: Anything else?

[6] A: I think that pretty much covers it.

[7] Q: As the manager –

[8] A: Just to add one thing to that for clarity, [9] it's important to note that the certification [10] requirements can be specific to the individual [11] product.

[12] Q: Tell me what that means.

[13] A: As an example if you had a product that [14] was not intended to be used for drinking water [15] purposes, a drain waste and vent product that would [16] not receive a health effects evaluation. So the [17] requirements are specific to the end use [18] application of the product.

[19] Q: As the manager of new product [20] certification did you do any of those tests or [21] reviews or did you review the work of others?

[22] A: My responsiblity was to review the work of [23] others.

[24] Q: So you don't do the testing?

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[1] A: I was not employed as a laboratory [2] technician.

[3] MR. GORDON: Did you want to say something?

[4] MS. CYZE: I am assuming we're going to go [5] through the list of this, but can we take a break [6] first?

[7] MR. GORDON: Fine.

[8] (A short break was taken.)

[9] BY MR. GORDON:

[10] Q: With respect to your work as manager of [11] new product certification, during that nine-month [12] period do you think you would have worked on the [13] certification of CPVC but you don't recall [14] specifically?

[15] A: It's extremely likely.

[16] Q: But you can't recall any specifically?

[17] A: No.

[18] Q: Your work as manager of new product [19] certification didn't involve establishing [20] certification criteria for CPVC products did it?

[21] A: No.

[22] Q: Would the same be true of your work as an [23] auditor?

[24] A: Yes.

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[1] Q: Okay. In June of 1994 did your job [2] position change?

[3] A: Yes.

[4] Q: Was that pursuant to your request?

[5] A: No.

[6] Q: Was it something that you wanted?

[7] A: Yes.

[8] Q: What was your new position?

[9] A: I was promoted to general manager of the [10] plumbing and related programs at NSF.

[11] Q: And is that the position that you have [12] now?

[13] A: Yes.

[14] Q: Can you tell me your duties and [15] responsibilities as general manager?

[16] A: I am responsible for the administration of [17] the program, the certification program. I am [18] involved in establishing policies and procedures [19] for the certification of products. I am involved [20] in providing input and information to our standards [21] development group with respect to various NSF [22] standards. I am responsible for making [23] presentations, providing information to regulatory [24] agencies or other interested parties about NSF and

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[1] its certification programs.

[2] **Q:** Anything else?

[3] **A:** That I think should cover it.

[4] **Q:** How many people do you supervise?

[5] **A:** I currently supervise six.

[6] **Q:** Of the six how many are clerical or [7] secretarial?

[8] **A:** None. I share a clerical support person [9] that is not included in that number of six.

[10] **Q:** What types of jobs do those six people [11] have?

[12] **A:** Those six people are involved in the [13] day-to-day contact with manufacturers of products [14] that are either seeking certification or that [15] already have certification but are seeking some [16] additional service.

[17] **Q:** The job that you had as manager of new [18] product certifications the person who has that job [19] now is that somebody that you supervise?

[20] **A:** That job no longer exists.

[21] **Q:** Was it merged into the job that you have [22] now?

[23] **A:** Yes, but not initially.

[24] **Q:** When was it merged into your job?

[1] **A:** In 1995 we underwent a reorganization or a [2] restructuring of the organization and the new [3] certification component of the operation was [4] divided up among the various certification [5] programs.

[6] **Q:** All right. So there's another section of [7] NSF that deals with products that aren't related to [8] plumbing for instance is that what you are telling [9] me?

[10] **A:** Correct.

[11] **Q:** And they do their own certification?

[12] **A:** And they do their certifications against [13] the standards that are appropriate for the product.

[14] **Q:** The plumbing programs at NSF what do those [15] include?

[16] **A:** Includes the plastic plumbing products [17] that are certified against standard 14, it includes [18] plumbing products and components that are [19] specifically designed for manufactured housing or [20] recreational vehicles under NSF standard 24. It [21] includes swimming pools and spa circulation system [22] components that are certified to NSF standard 50, [23] and it includes mechanical plumbing devices.

[24] **Q:** Can you tell me what that is?

[1] **A:** That could be a product as varied as a [2] faucet that you would have in your home to a urinal [3] in the men's room. It represents a varied group of [4] products.

[5] **Q:** And what standard is that?

[6] **A:** Those standards vary as well, they're not [7] certified to an NSF standard. Typically they're [8] certified to either an ASSE or an ASNE standards.

[9] **Q:** Does NSF certify any plumbing products [10] that are not plastic?

[11] **A:** Yes.

[12] **Q:** Does it certify plumbing products used for [13] potable water distribution systems that are not [14] plastic?

[15] **A:** Yes.

[16] **Q:** Are those under standard 14 as well?

[17] **A:** They certainly could be.

[18] **Q:** Does it certify copper products?

[19] **A:** Yes.

[20] **Q:** Anything else with respect to potable [21] water?

[22] **A:** I am not sure I understand, in terms of [23] other materials?

[24] **Q:** Yes, sir.

[1] **A:** Yes.

[2] **Q:** What would those be?

[3] **A:** Could be galvanized, various brass alloys, [4] but it's certainly not limited to that those are [5] just examples.

[6] **Q:** Okay. Since becoming the general manager [7] have you been involved in the certification of any [8] CPVC potable water distribution system products?

[9] **A:** Yes.

[10] **Q:** Can you tell me what those are?

[11] **A:** The products would have been various pipe [12] fittings, transition fittings, and solvent cement.

[13] **Q:** Can you specify any that you have worked [14] on of any of these things?

[15] **A:** In terms of specific manufacturers?

[16] **Q:** Or products.

[17] **A:** Specific manufacturers King Brothers I [18] believe was a fitting for CPVC. Nipko was the [19] company name and that was fitting products and [20] piping products.

[21] **Q:** Are all CPVC plumbing products evaluated [22] against standard 14?

[23] **A:** From the standpoint that the certification [24] is a voluntary program?

[1] **Q:** That's correct – let me ask you in a [2] different way, I think I understand why you are [3] confused. If you are going to certify a CPVC [4] plumbing product the certification process involves [5] standard 14; is that correct?

[6] **A:** Yes.

[7] **Q:** Does it involve any other standards?

[8] **A:** Yes.

[9] **Q:** Okay. What would those be?

[10] **A:** NSF standard 61.

[11] **Q:** And what does that relate to?

[12] **A:** That relates to health effects for [13] products that are intended to be used in a drinking [14] water or potable water system.

[15] **Q:** Okay.

[16] **A:** And that is by reference in standard 14 it [17] refers you back to 61.

[18] **Q:** And standard 14 is what?

[19] **A:** Standard 14 addresses both the performance [20] aspects of the product, it addresses quality [21] control aspects of the product, it addresses [22] marketing, labeling, record keeping in terms of the [23] manufacturer of the product, and of course I [24] already mentioned that it references standard 61

[1] for those products that are intended for drinking [2] water application.

[3] **Q:** So NSF standard 14 relates to all of the [4] things involved in getting the product manufactured [5] and installed, and 61 relates to what the product [6] will do once it's installed; is that a fair way to [7] divide it up?

[8] **A:** Not quite, but the standard 14 does not [9] address installation.

[10] **Q:** And neither does 61, right?

[11] **A:** No.

[12] **Q:** Do any NSF standards address CPVC [13] installation?

[14] **A:** No.

[15] **Q:** To your knowledge has NSF studied the [16] effects of improper installation of CPVC pipe upon [17] performance or health of consumers?

[18] **A:** Not to my knowledge.

[19] **Q:** I'd like you to tell me a little bit about [20] NSF, how is it funded?

[21] **A:** NSF is a not-for-profit organization and [22] we receive funding in several different ways. One [23] avenue is charging for the services that we [24] provide.

[1] **Q:** That's the certification?

[2] **A:** For the certification, yes.

[3] **Q:** Any others?

[4] **A:** We also receive grants.

[5] **Q:** From what?

[6] **A:** From federal governments, federal [7] agencies, and at least in my mind those

are [8] probably the two primary avenues.

[9] **Q:** Does part of NSF's funding come from the [10] B.F. Goodrich Company?

[11] **MS. CYZE:** Object to the form of the question.

[12] **BY MR. GORDON:**

[13] **Q:** Go ahead, you can answer.

[14] **A:** Would you repeat the question?

[15] **Q:** Does any portion of NSF's funds come from [16] the B.F. Goodrich Company?

[17] **A:** B.F. Goodrich is a manufacturer that has [18] products certified against various NSF standards [19] and we do charge them for that service.

[20] **Q:** Do you charge for allowing a company to [21] use the NSF mark?

[22] **A:** There is a listing fee that we charge that [23] actually it's not a direct charge per the use of [24] the mark, but it's a charge that relates to the

[1] publication and the maintaining of the data base [2] that identifies what products have been certified. [3] We don't charge a mark usage fee specifically.

[4] **Q:** Let's suppose I am manufacturing solvent [5] cement, if you tested and find that it meets the [6] NSF standards then you'll put my product on your [7] data base and you'll charge me for that?

[8] **A:** And I will charge you an annual fee for [9] that, yes.

[10] **Q:** Do you know what the fee is?

[11] **A:** $1,800 per year.

[12] **Q:** Per product?

[13] **A:** Per product location, it's not product [14] specific.

[15] **Q:** Other than this listing fee and testing [16] fees does NSF receive any additional type of [17] funding from the B.F. Goodrich Company?

[18] **MS. CYZE:** Objection, he never testified that [19] he received any funding from B.F.G., the B.F.G. [20] paid the prices they charged.

[21] **BY MR. GORDON:**

[22] **Q:** I will rephrase the question, I don't know [23] that it matters. B.F. Goodrich pays you folks at [24] NSF to test its products to determine whether or

[1] not they meet the NSF requirements or standards; is [2] that correct?

[3] **A:** Yes.

[4] **Q:** You charge for testing?

[5] **A:** Any manufacturer that requests services we [6] charge for that service.

[7] **Q:** And B.F. Goodrich pays NSF a listing fee [8] does it not?

[9] **A:** B.F. Goodrich does maintain a listing with [10] NSF and we do charge a listing fee.

[11] **Q:** Okay. Other than listing fees and testing [12] fees does B.F. Goodrich provide any additional [13] funds to the NSF in any form?

[14] **A:** There are other components of the [15] certification program for instance the inspections, [16] any aspect of that service that we do charge a [17] manufacturer for so it's not limited just to [18] listing and testing.

[19] **Q:** Okay. Now, we have inspections, [20] certifications, listing those three types of [21] charges, are there any additional types of charges [22] that would be imposed on B.F. Goodrich?

[23] **A:** Could be professional services during the [24] year by various NSF personnel.

[1] **Q:** Can you give me an example?

[2] **A:** As any manufacturer could if they wanted [3] to bring a product for certification there would be [4] some professional service time from our toxicology [5] group if that product had a drinking water and use [6] application. So that would be actual time billed [7] back to that manufacturer in the amount of time [8] that the toxicologist spent reviewing the various [9] ingredients and components of the product.

[10] **Q:** Is that prior to the certification process [11] or is that part of the certification process?

[12] **A:** It could be part of the certification [13] process.

[14] **Q:** Other than grants from federal agencies [15] does NSF receive grants from manufacturers?

[16] **A:** I am not sure I understand the use of [17] grants in that context.

[18] **Q:** Here is some money to use –

[19] **A:** Free money.

[20] **Q:** Well, nothing is free. I am not going to [21] buy into the free money concept, but it's money [22] given not for one of these other purposes I [23] suppose?

[24] **A:** No.

[1] **Q:** Okay. Who runs NSF?

[2] **A:** We have a president and a board of [3] directors.

[4] **Q:** Who is the president?

[5] **A:** Dennis Mangino.

[6] **Q:** Do you know what he was before he was with [7] NSF?

[8] **A:** I report to him, he was in upper [9] management with a steal company, Warton Steal.

[10] **Q:** Then you have a board of directors?

[11] **A:** Yes.

[12] **Q:** And what types of people are on the board [13] of directors, are they drawn in from various [14] disciplines?

[15] **A:** Yes.

[16] **Q:** Can you tell me some examples, please?

[17] **A:** To be honest with you I don't know. I [18] have met several of them over the course of the [19] years I have been with NSF, but I am not sure what [20] their backgrounds are in terms of discipline.

[21] **Q:** Do you know whether there is a [22] representative of B.F. Goodrich on the board of [23] directors?

[24] **A:** There is not I do know that.

[1] **Q:** Has there ever been a representative of [2] B.F. Goodrich on the board?

[3] **A:** I don't know.

[4] **Q:** Now, does NSF also have various [5] committees?

[6] **A:** Yes.

[7] **Q:** And they have a joint committee on [8] plastics?

[9] **A:** Yes.

[10] **Q:** What is the role of the joint committee on [11] plastics?

[12] **A:** The joint committee is part of the [13] consensus process that NSF uses to develope [14] standards. And that process is a balanced approach [15] where we bring manufacturers of the effective [16] products, users of the product, and regulatory [17] officials, representatives from the regulatory [18] community together in a balanced forum to develope [19] the requirements for the standard.

[20] **Q:** Do you know when standard 14 – strike [21] that.

[22] Would standard 14 have been developed [23] through the joint committee on plastics?

[24] **A:** Yes.

[1] **Q:** Do you know when standard 14 was first [2] promulgated?

[3] **A:** I believe the first adoption by the NSF [4] board was in 1965.

[5] **Q:** Was that for CPVC or PVCV?

[6] **A:** I don't know, I have to take a look at the [7] original documents.

[8] **Q:** Has standard 14 been revised?

[9] **A:** It's been revised numerous times.

[10] **Q:** I am looking at standard 14 which is [11] Exhibit B to your rule 26 report, why don't you [12] take out your copy and I will look off of this [13] one.

[14] A: Okay. So you're looking at standard 14?

[15] Q: Yes, sir.

[16] A: Okay.

[17] Q: My standard 14 has some unnumbered pages [18] at the beginning, but what appears to be the page [19] opposite the disclaimer page shows the original [20] adoption in 1965 and revisions on 11 occasions [21] thereafter; is that correct?

[22] A: That is correct.

[23] Q: Why were revisions necessary if you know?

[24] A: The standard actually requires that it be

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[1] reviewed for possible revision at least once every [2] five years. And revisions can happen more [3] frequently if there's a need based on changes in [4] technology, changes in available information that [5] warrant some modification of the standard.

[6] Q: It appears that this was revised for the [7] first time 12 years after adoption, it was [8] originally adopted in 1965, the first revision was [9] 1977, do you know the reason for the 1977 revision?

[10] A: No, I don't.

[11] Q: Do you know the reasons for any of the [12] revisions?

[13] A: Specifically the 1996.

[14] Q: And what was the reason for the 1996 [15] revision?

[16] A: It was an update of the standard.

[17] Q: What changes were made in the standard?

[18] A: In order to give you an accurate account [19] of that I could not give you an accurate account of [20] that, there were numerous changes to the standard. [21] My recollection is that they were primarily [22] editorial.

[23] Q: Now, standard 14 is the performance [24] standard; is that correct?

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[1] A: It's a standard that addresses performance [2] requirements.

[3] Q: Included in the performance requirement [4] standard is one of the things that NSF looks at the [5] interaction between a product and other products in [6] the environment; do you understand that question?

[7] A: Well –

[8] Q: Let me rephrase it. [9] In taking the depositions of various B.F. [10] Goodrich employees I have learned that CPVC pipe [11] may crack if it comes in contact with certain other [12] products or materials, does standard 14 address the [13] susceptibility of CPVC to cracking because of it [14] coming into contact with any other materials or [15] products?

[16] A: No.

[17] Q: In reviewing standard 14 and the [18] requirements for plastic piping system components [19] it appeared to me that what standard 14 addressed [20] is for lack of a better word the strength of the [21] product; is that a fair characterization?

[22] A: It comes down I think to semantics in [23] terms of what you mean as strength. By reference [24] back to an ASTM standard as an example provides

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[1] information about dimensional requirements, the [2] physical properties of the product. And if you [3] include all of those in a broad definition of [4] strength then I guess the answer would be, yes.

[5] Q: Okay. Can you tell me about the types of [6] things that your referencing when you say physical [7] characteristics of the product?

[8] A: Depending on the product it could be [9] impact resistance, burst pressure ability to [10] withstand thermasiclic pressures.

[11] Q: What is that?

[12] A: Basically cycling, pressure cycling, [13] ramping the pressure up, taking the pressure down.

[14] Q: Anything else?

[15] A: Again it could be very product specific [16] depending on the standard that you're looking at. [17] In this case if you are talking about ASTM [18] standards it depends on the product. Essentially [19] whatever properties are important relative to [20] determining that product's ability to perform in an [21] acceptable manner.

[22] Q: I am talking about CPVC pipe and [23] fittings.

[24] A: Okay.

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[1] Q: Your standards relate to standard [2] resistance, burst pressure, pressure cycling, [3] anything else?

[4] A: In the case of specifically CPVC products [5] standard 14 by reference will take you to ASTM [6] 2846, and in 2846 you will find the dimensional [7] requirements, you will find requirements for burst [8] pressure, there's a thermasiclic test in that ASTM [9] standard, and requirements for hydrostatic design [10] stress for piping.

[11] Q: Hydrostatic design stress is what?

[12] A: The ability of the pipe – basically it's [13] the pressure rating of the pipe, the ability of the [14] pipe to withstand pressure.

[15] Q: Okay. Do you also test the ability of the [16] pipe to withstand warm temperatures or hot [17] temperatures?

[18] A: The testing in 2846 is conducted at an [19] elevated temperature.

[20] Q: You just said 2846 I thought a little [21] while ago I thought you said 4826.

[22] A: No, it's 2846.

[23] Q: 2846 relates to temperatures?

[24] A: It relates to CPVC, the actual title is

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[1] standard specification of chlorinated polyvinyl [2] chloride, CPVC, plastic hot and cold water [3] distribution systems.

[4] Q: How long has copper pipe been used for [5] potable water distribution to your knowledge?

[6] A: I have no idea.

[7] Q: A long time?

[8] A: I have no idea.

[9] Q: Would you think it would be more than 50 [10] years?

[11] A: I'd be guessing.

[12] Q: Okay. Is it longer than CPVC?

[13] A: Yes, I would believe so.

[14] Q: Are we – strike that. [15] Are the people who look at the performance [16] of products such as copper pipe for potable water [17] distribution still learning about copper pipe – I [18] guess what I am getting at is are we learning today [19] that maybe there is a problem that exists with [20] copper pipe that we didn't know about 10 years ago.

[21] MS. CYZE: Objection, I don't think you've [22] established a foundation as to whether he has [23] enough knowledge about copper piping to know that.

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[1] BY MR. GORDON:

[2] Q: Well, I don't want you to answer anything [3] you don't know, having said that can you answer the [4] question?

[5] A: My area of expertise is not copper in [6] terms of copper piping.

[7] Q: You're the general manager of plumbing and [8] related programs?

[9] A: True.

[10] Q: Copper is used for plumbing purposes?

[11] A: True.

[12] Q: Okay. In your present position do you [13] oversee the certification of any products involving [14] copper?

[15] A: Yes. Those products are specifically [16] fittings that are used in a plastics plumbing [17] system.

[18] Q: Those are transition fittings?

[19] A: Could be transition fittings, if you're [20] talking about specifically CPVC,

yes, those would [21] be transition fittings.

[22] **Q:** Are those products governed by an NSF [23] standard?

[24] **A:** They're within the scope of both standard

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[1] 14 and standard 61, and they're also addressed in [2] ACTMD 2846.

[3] **Q:** In your tab B I don't see any tables [4] relating to copper fittings, maybe I missed them.

[5] **A:** You're in the quality control section?

[6] **Q:** Well, ASTM just deals with [7] plastics – excuse me, NSF 14 just deals with [8] plastics?

[9] **A:** That's not correct.

[10] **Q:** Okay.

[11] **A:** It deals with – if you go back to the [12] scope of the standard it applies to thermal plastic [13] and thermal set plastic piping system components [14] and the keyword is components. In the case of the [15] transition fitting if it's a CPVC copper transition [16] fitting that is part of a CPVC system it's a [17] component part of that system, so it's included in [18] the standard.

[19] **Q:** Okay.

[20] **A:** It would be considered to be within the [21] scope of the standard.

[22] **Q:** Maybe you can show me in standard 14 where [23] it talks about copper fittings?

[24] **A:** In terms of CPVC?

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[1] **Q:** In terms of anything.

[2] **A:** Okay. If you go to the normative [3] references –

[4] **Q:** Can you give me a page?

[5] **A:** Beginning on page one – on page two down [6] at the bottom of the first column there's a [7] reference to the standard that we have already [8] mentioned ASTM D 2846, and if you go to that [9] standard it includes plastic to metal transition [10] fittings in section five of 2846.

[11] **Q:** Okay. Other than with reference to other [12] documents did I miss something in tab B standard 14 [13] that directly addresses copper fittings?

[14] **A:** If you go to the – yes, I think you did.

[15] **Q:** Can you show me what it is that I missed?

[16] **A:** If you go to the back, section 9.8, if you [17] look at page 17, which should be table 6, there's a [18] quality control table for CPVC fittings and one of [19] the reference standards for those fittings is 2846 [20] that would be inclusive of the transition fittings, [21] so it's those types of references.

[22] **Q:** Except for references to another document [23] I didn't see anything in standard 14 that directly [24] addressed copper.

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[1] **A:** True.

[2] **Q:** Is there an NSF standard that deals with [3] copper piping for potable water?

[4] **A:** Yes.

[5] **Q:** Okay. What standard is that?

[6] **A:** That would be standard 61.

[7] **Q:** Now, standard 61 is your tab A, correct?

[8] **A:** Yes.

[9] **Q:** And that relates to health effects?

[10] **A:** Yes.

[11] **Q:** And you told me that standard 14 deals [12] more with performance?

[13] **A:** It addresses both performance, quality [14] control, and health effects.

[15] **Q:** Is there an NSF standard for copper that [16] is comparable to NSF standard 14?

[17] **A:** No.

[18] **Q:** Is there a reason that there isn't?

[19] **A:** I am not sure why there's not.

[20] **Q:** Do you know if there were any [21] representatives of the copper pipe industry that [22] were involved in the development of standard 14 or [23] any of the revisions to it?

[24] **A:** Historically I don't know.

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[1] **Q:** Would the same be true for standard [2] 14 – I mean standard 61?

[3] **A:** Not having been involved in the standard [4] 61 standards process I don't know.

[5] **Q:** Okay. Were you involved in the revision [6] to standard 14?

[7] **A:** The 1996 revision, yes.

[8] **Q:** Were any representatives of the copper [9] industry involved in the revisions to the 1996 [10] revisions to standard 14?

[11] **A:** Yes.

[12] **Q:** And who was that?

[13] **A:** Representatives from Nipko.

[14] **Q:** Nipko is a plastic pipe manufacturer and [15] they also manufacture copper?

[16] **A:** Yes. [17] I believe that's the only one.

[18] **Q:** Do you know how many representatives in [19] the plastic pipe and fitting industry were on the [20] committee that were involved in the 1996 revisions?

[21] **A:** I believe six or seven.

[22] **Q:** And that would include the Nipko [23] representative; is that correct?

[24] **A:** Yes.

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[1] **Q:** And a company called Genova?

[2] **A:** And actually looking at the list in the [3] current version of standard 14 I believe I miss [4] spoke, Nipko was at that meeting, but I would have [5] to, check to make sure that they are now on the [6] committee, but we did have people that were in [7] attendance.

[8] **Q:** But they weren't on the committee?

[9] **A:** They are not listed.

[10] **Q:** Now, going back to the plastic [11] representatives on the committee we have – well, [12] on page roman numeral nine there are [13] representatives of industry up at the top, are all [14] of those companies manufacturers of plastic [15] plumbing products?

[16] **A:** No.

[17] **Q:** All right. Is Occidental?

[18] **A:** Okay. Occidental is a manufacturer of [19] materials.

[20] **Q:** Materials for manufacturing plastic pipe [21] for?

[22] **A:** Yes.

[23] **Q:** Same for Morton Thyacal?

[24] **A:** Yes.

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[1] **Q:** Cantex?

[2] **A:** Cantex is a final product producer.

[3] **Q:** Genova?

[4] **A:** Genova as well.

[5] **Q:** Industrial Polychemical Service?

[6] **A:** Final product.

[7] **Q:** Creslien Plastic Pipe Company does what [8] its name suggests?

[9] **A:** Yes, plastic pipe.

[10] **Q:** Now, this one fellow here, Robert Wilgain [11] from PSI (MPA), Inc., what is that?

[12] **A:** That's a consulting firm.

[13] **Q:** And they consult with whom?

[14] **A:** That I don't know.

[15] **Q:** Are we – strike that. [16] Are you in your industry or your portion [17] of the plastic piping industry still learning about [18] CPVC.

[19] **MS. CYZE:** Objection, I don't think the [20] characterization of NSF as part of the plastic [21] piping industry is accurate based upon any of the [22] testimony that Mr. Coiner gave. He said it was an [23] independent not-for-profit agency, so to lump it [24] in –

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MR. GORDON: I will just rephrase it.

BY MR. GORDON:

Q: Are you folks at NSF still learning about CPVC?

A: No.

Q: You know everything there is to know about it?

A: We have a solid understanding of the standards that we have discussed, yes.

Q: So you know everything that you need to know about CPVC?

A: Based on the information available today.

Q: A few minutes ago we discussed the fact that your standard has been revised 11 times over the past 32 years, were some of those revisions necessitated because you learned things one day that you didn't know the day before?

A: That I don't know.

Q: Have you read any studies about the health effects CPVC piping products and solvent cements on the health of people who drink the water that comes through those products?

A: No.

Q: Have you read any studies that indicated

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that chemicals or compounds used in the manufacturing or installation of CPVC potable water systems may leach from those systems into the drinking water?

A: I am not sure I understood.

Q: Do you understand leaching?

A: Yes.

Q: Leaching is where chemicals that are used in a product remove themselves from that product and go into another product; is that fair?

A: Okay.

Q: Is that your understanding of leaching?

A: I understand the concept, yes. But I am still not clear of the question.

Q: Are you aware of any studies that have determined that compounds or materials utilized in the manufacturer or installation of CPVC potable water systems may leach from those systems into the water?

A: Yes.

Q: Okay. What studies are those?

A: I don't recall the specific names of the studies or the documents.

Q: And what did those studies show?

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A: Looking at various products that extract out into the water.

Q: Do you know what has been found to leach out of CPVC pipes, fittings, and solvent cements?

A: No, I don't.

Q: Is that something – strike that. Is leaching something that is looked at by NSF in its development of standards?

A: From the standpoint of standard 61, yes.

Q: Okay. Now, standard 61 is tab A of your rule 26 report; is that correct?

A: Yes.

Q: Now, standard 61 was originally promulgated in 1988?

A: Yes.

Q: And in the nine years since it was promulgated it's been advised 11 times; isn't that correct?

A: Yes.

Q: Do you know the reason for any of those revisions?

A: Not specifically, no.

Q: Would you think that the reasons may be necessitated because we're learning more about the

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health effects of CPVC pipe?

A: I don't know.

Q: You weren't involved in the revisions of standard 61?

A: There's a separate standards department that works directly with the joint committee and development of the standards. I provided – in my role I provided information on input to that group, but I am not a member or directly involved.

Q: So you weren't involved in any of the revisions of 61?

A: From an involvement standpoint I have attended the meetings and I have answered questions, but that's the extent of my involvement.

Q: Do you remember what type of questions you answered?

A: Not specifically.

Q: Can you show me which portion of standard 61 deals with leaching.

A: And I guess I am not – we probably need to go over the leaching issue again, I am not clear on what you are referring to specifically when you say leaching.

Q: You said you understood the word leaching?

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A: From the standpoint of the standard the standard is addressing contaminants that could come out of a product that's in contact with drinking water. In terms of the terminology it's not talking about leaching.

Q: I am talking not about –

A: In terms of the word usage.

Q: All right. My hand is in contact with the table, pieces of the table are not going off of the table into my hand.

A: I will take your word for it.

Q: By way of illustration. What I am talking about in terms of leaching is a part of the product, a part of the chemical for instance that are used in the manufacture of CPVC pipe, fittings, or solvent cement removes itself or is removed from the CPVC product and goes into the drinking water?

A: Okay.

Q: That's leaching.

A: Okay.

Q: Now, having come to this agreement on what leaching is you said that you are available of studies that address leaching from CPVC into water, but you told me that you couldn't remember the

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studies and you don't –

A: I didn't – that's not the way I recollect that question.

Q: Okay.

A: The way I recollect the question that you asked was was I aware of any studies not specific to the product type. If you mentioned CPVC specifically as the product type then I would need to change my answer.

Q: Okay. Well, I did reference CPVC.

A: I apologize, the studies I was referring to were studies that relate to PVC and again I don't remember the title of those studies, but I must have misunderstood your question.

Q: You don't know about any studies regarding CPVC leaching?

A: I have not seen any or read any specific studies about CPVC.

Q: Are you aware of any studies – strike that.

Do any of the NSF standards deal with proper installation procedures for the health of installers of CPVC?

A: The standards don't address installation

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issues so the answer is, no.

Q: Do NSF standards address the appropriate method for testing completed CPVC potable water systems?

A: They address testing representative samples of the various products, but we don't do – if you're

asking if we do systems tests where you have a complete residential or commercial system installed.

Q: I am not asking you whether you do the tests I am asking you whether or not you have standards, public standards that address how completed systems should be tested?

A: The standard – I assume we're talking about the context of standard 61?

Q: Or any other standard.

A: The standards don't address installation, so I am not sure I follow the question, that's why I am struggling with it.

Q: If I am a builder and I construct a house with a CPVC potable water distribution system within the house and it's time to inspect it I can't turn to an NSF standard to determine the appropriate way to test the system can I?

A: Well, the product before you install it should meet the standards.

Q: I am talking about –

A: I mean if you're trying to determine whether it meets the standards after you installed the system I think that's after the fact.

Q: No. This is to determine whether or not the system is going to work once it's installed?

A: So checking the installer?

Q: Correct. There is no NSF standard for checking the installation.

A: We're not involved in installation.

MR. GORDON: Let's take a break here.

(A short break was taken.)

BY MR. GORDON:

Q: Mr. Coiner, when were you first contacted about being an expert witness in this case?

A: Approximately May of this year.

Q: And who contacted you?

A: Susan Franzetti was the original contact.

Q: Do you know how she knew to call you?

A: No, I do not.

Q: Had you ever met her before?

A: No.

Q: Did anybody from NSF or any other company tell you that she would be calling?

A: No. I do believe that either Susan or Marybeth Cyze indicated that they were given my name by B.F. Goodrich.

Q: Have you worked with B.F. Goodrich employees in the certification process?

A: Yes, I have.

Q: And who was that that you have worked with?

A: Numerous contacts at B.F. Goodrich, would you like me to list them out?

Q: Please.

A: Don Townely.

Q: How did you come in contact with Mr. Townely?

A: He is the corporate contact representing B.F. Goodrich. In terms of the work that we do with the manufacturer we have a preference of establishing or having the manufacturer establish one person to be the central focus for all of the contacts. It just makes things a little bit logistically easier for us.

Q: And who else have you dealt with?

A: Andy Olay (sic).

Q: In what regard?

A: In regards to participation in meetings at NSF or at B.F. Goodrich where Andy was present.

Q: What type of meetings did you have while he was present?

A: Meetings relative to the possible certification of products for B.F. Goodrich like in one case I gave a presentation on the certification process.

Q: Where was that?

A: I believe that was actually at NSF.

Q: And you gave it to B.F. Goodrich?

A: It could have been at B.F. Goodrich. In my capacity I give numerous of those presentations. And Mr. Olay has also attended various standard meetings, joint committee type meetings at NSF.

Q: Anybody else at Goodrich?

A: Julian Steinberg.

Q: And what does Mr. Steinberg do?

A: Mr. Steinberg is a person that I run in to at the plastic pipe and fitting association meetings, he typically attends those.

Q: Do you know what he does for B.F. Goodrich?

A: I am not quite sure how he fits into the corporate structure at Goodrich whether he is in sales or marketing or technical services.

Q: Anybody else at Goodrich that you have worked with?

A: I have worked with Bob Welgain when he was an employee of B.F Goodrich.

Q: What is he now?

A: He has a consulting firm of some type.

Q: Anybody else at Goodrich?

A: Casual meetings with people at trade shows other than that no.

Q: During your conversation with Susan Franzetti in May of 1997 what did she say to you and what did you say to her?

A: She explained to me a little bit about the issue at hand, and we discussed the possibility of NSF providing an expert witness, and that discussion was conceptual in terms of the types of individuals that they would be looking for.

Q: Have you ever been an expert witness before?

A: Yes.

Q: And when was that?

A: That was in 1995 I believe.

Q: What type of case was it?

A: It was – you know, I am not sure whether to call it a personal injury or – it was a product related case.

Q: Can you give me a little more detail?

A: It involved a solvent cement product that had been involved in a fire and there was an injury that resulted from that.

Q: From what?

A: From the cement on fire, and the individual who was burned was suing a number of individuals including the manufacturer and I provided testimony about NSF standards, NSF certification, and product labelling.

Q: Do you remember what the product was?

A: I remember the manufacturer, I don't remember the specific product name. It was Parchem Southern.

Q: Was it a CPVC solvent cement?

A: I believe it was a PVC cement.

Q: Did you receive compensation for your

testimony?

A: Yes.

Q: How much did you receive?

A: I don't recall the amount.

Q: Did it go to you or NSF?

A: It would have gone to NSF.

Q: And NSF is being compensated for your time in this case?

[9] A: Yes.

[10] Q: According to your expert report NSF is [11] being paid $300 per hour, is that a standard fee?

[12] A: That would be a standard fee for the level [13] of service – the level of the person that's [14] providing the testimony.

[15] Q: $300 dollars is the standard for your [16] level?

[17] A: Apparently NSF considers my time that [18] valuable.

[19] Q: Going back to your conversation with Susan [20] Franzetti you were telling me what was discussed [21] and you just said you discussed in general somebody [22] from NSF providing expert testimony, what else was [23] discussed in that conversation?

[24] A: My recollection is that is essentially all

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[1] that was discussed. At some point in that [2] conversation I either asked for or it was [3] volunteered a copy of the pleading and I did [4] subsequent to that conversation receive a copy of [5] the pleading.

[6] Q: And what's the next thing that happened [7] with respect to your engagement in this case?

[8] A: The next thing that happened is that I [9] suggested that they talk to two individuals at NSF, [10] one is a toxicologist, one is an engineer that seem [11] to fit at that time what they were looking for.

[12] Q: Who was the toxicologist?

[13] A: David McFaden.

[14] Q: And who was the engineer?

[15] A: Jim Pasco.

[16] Q: Okay. Did somebody follow-up on that?

[17] A: It's my understanding that there were some [18] discussions between either Marybeth Cyze size or [19] Susan Franzetti and both Jim Pasco and David [20] McFaden, but I was not involved in those [21] discussions, at that point I was essentially out of [22] it.

[23] Q: And when did you reemerge?

[24] A: I reemerged in late July.

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[1] Q: Who were you contacted by?

[2] A: I was contacted by Marybeth.

[3] Q: And what did she say to you and what did [4] you say to her?

[5] A: At that time she was attempting to contact [6] David McFaden and it's my understanding that the [7] decision had been made that that would be the [8] expert; however, due to time constraints, David [9] being on vacation and the issues involving more [10] than just the toxicology portion of this a decision [11] was made at that time to shift to me instead of [12] David.

[13] Q: Anything else said during that [14] conversation?

[15] A: We discussed the standards, standard 14, [16] standard 61, the ASTM standard, and I guess to some [17] degree the opinions.

[18] Q: With respect to opinions what did she say [19] to you and what did you say to her?

[20] A: In the context of the NSF standards what [21] was the position of NSF relative to these products.

[22] Q: In can you explain what you meant by that?

[23] A: Basically it would be the information [24] that's in the statement of opinions, the expert

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[1] report.

[2] Q: Okay. How long did this conversation [3] last?

[4] A: 45 minutes to a half hour.

[5] Q: What's the next thing that happened with [6] respect to your engagement?

[7] A: The next thing that happened, at that time [8] I was not in my office, I was travelling. When I [9] returned to my office David was still on vacation, [10] and I retrieved his file. When he returned to the [11] office he and I looked at the file.

[12] Q: Anything else?

[13] A: I can keep on going.

[14] Q: Keep going, I want to know what happened [15] after you looked at the file?

[16] A: We looked at the file, the majority of the [17] file – in fact with the exception of the pleadings [18] which I had already seen everything in the file was [19] not information that was germane to the opinions [20] that I would be representing.

[21] Q: What was in the file?

[22] A: It was information primarily focused at [23] toxicology.

[24] Q: If I wanted to look at the documents that

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[1] were in his file what would I be looking for or [2] looking at?

[3] MS. CYZE: I can give you a base number list to [4] save time.

[5] BY MR. GORDON:

[6] Q: I am going to mark this as Coiner's [7] Deposition Exhibit No. 2.

[8] After it was determined that the [9] information in his file was not going to be related [10] to your opinions what did you do next after your [11] meeting with Mr. McFaden?

[12] A: I returned that information to David and I [13] began working on the expert report.

[14] Q: I am going to show you what has been [15] marked as Coiner Deposition Exhibit No. 1, is that [16] the expert report that you just referred to?

[17] A: Yes.

[18] Q: The actual report which is some eight [19] pages long did you write the report?

[20] A: Yes.

[21] Q: You wrote the first draft?

[22] A: I did receive a first cut from Marybeth [23] that had been based on a telephone conversation [24] that she and I had.

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[1] Q: Where is that?

[2] A: I believe that was in the file.

[3] Q: One you say in the file –

[4] A: That was in the file information that I [5] believe Marybeth gave you this morning, it should [6] be dated July 24th.

[7] Q: I am going to show you what has been [8] marked Coiner Deposition Exhibit No. 3, is that the [9] document that you received from Marybeth?

[10] A: Yes.

[11] Q: The first cut you referred to?

[12] A: Yes. This would have been the first [13] draft, the first cut.

[14] Q: And in that she listed five statements of [15] opinion; is that correct?

[16] A: Correct.

[17] Q: What did you do when you received this [18] from Marybeth?

[19] A: I began to make editorial revisions, [20] changes.

[21] Q: And then what did you do with these [22] changes?

[23] A: Those ultimately I sent back to Marybeth.

[24] Q: Do you have a copy of what you sent her?

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[1] A: No, I do not.

[2] Q: You didn't keep a copy?

[3] A: No.

[4] Q: Is there a reason that you didn't keep a [5] copy?

[6] A: I am not in the habit of keeping copies.

[7] Q: Were you instructed not to?

[8] A: No, I was not.

[9] Q: Was it done on a computer?

[10] A: The typing was done by Marybeth's office, [11] by someone in her office, I did not do the typing.

[12] Q: When you made revisions how did you make [13] the revisions?

[14] A: I made the revisions – I made the [15] revisions by hand.

[16] Q: On this piece of paper?

[17] A: I may have done – in terms of that piece [18] of paper – at this stage if we go back to the July [19] 24th document I may have done these on a computer [20] in terms of the changes to the statement of [21] opinions.

[22] Q: Okay.

[23] A: But the vast majority were done by hand [24] and then faxed back.

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[1] Q: Well, your actual report is eight pages?

[2] A: Yes.

[3] Q: What Marybeth sent you was one page?

[4] A: Yes.

[5] Q: You wrote out the eight pages in longhand?

[6] A: No, I did not. If you look at the basis [7] and reason section the large portion of that [8] actually comes directly out of standard 61, and [9] what Marybeth and I did was over the telephone [10] again reviewing the standards and what I wanted to [11] try to accomplish instead of just having everyone [12] try to read through the standard and make all of [13] the connections what I wanted to accomplish was [14] trying to take what I considered the more germane [15] parts of the standard and provide that as an easy [16] reference for information and that begins with the [17] introduction on the bottom of page one.

[18] Q: Okay. Are you telling me that the basis [19] and reasons for opinions one and two is for lack of [20] a better word a cut and paste job for standard 61?

[21] A: I would not term it a cut and paste job, [22] but substantially that information is in the [23] standard, in various portions of the standard.

[24] Q: How did the basis and reasons for opinions

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[1] number one and two come into existence, did you [2] xerox copies of the standard, did you rely on [3] Marybeth to do the typing portions of the standard, [4] or did you specify portiones that you wanted in?

[5] A: I did rely somewhat in Marybeth's office [6] to do the typing.

[7] Q: I am not talking about the typing, I am [8] talking about how did this – whoever did the [9] typing and assume that's not Marybeth either, [10] whoever did the typing how did they know what to [11] type, is it something you gave them or was it [12] something she gave them?

[13] A: Based on my discussions with Marybeth it [14] would have been something that she gave them based [15] on her notes from our conversations in terms of [16] what sections were applicable and we're talking [17] about from the introduction down.

[18] Q: Okay. So from the introduction down is [19] something that was ultimately selected and typed by [20] people at the law firm for B.F. Goodrich?

[21] MS. CYZE: Objection, that's not what he [22] stated.

[23] BY MR. GORDON:

[24] Q: That's my question.

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[1] A: The answer to that is, no.

[2] Q: Which words from the introduction on down [3] did you suggest to Marybeth should be in the [4] portion?

[5] A: All of it, we discussed this at length [6] with a copy of the standard.

[7] Q: You told me I think you talked for 30 [8] minutes to 45 minutes.

[9] MS. CYZE: You didn't ask him – I object, [10] you're mischaracterizing his testimony, I have [11] never heard a question was that the only time you [12] ever talked to her, I think you're making [13] assumptions.

[14] BY MR. GORDON:

[15] Q: You had other discussions with Marybeth [16] during the formation of this document which is [17] Coiner's Exhibit No. 1?

[18] A: Numerous.

[19] Q: Okay. I would like to know which of these [20] words did you either write yourself or specify [21] should be included in this report?

[22] MS. CYZE: I object, let's break the question [23] down into two. He has already answered the second [24] one just a minute ago he said all of them that he

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[1] specified. If you want to break the question down [2] into two separate ones.

[3] BY MR. GORDON:

[4] Q: Which did you write, which words?

[5] A: I wrote statement of opinions, basis and [6] reasons for opinions numbers one and two. At the [7] section entitled introduction, this information is [8] an assembly of information that also appears in [9] standard 61, and the intention was to provide that [10] as a convenience. I wrote the basis for opinions [11] number 3, and the section entitled ANSI NSF [12] standard 14 for plastics.

[13] Q: The basis for opinion number 3 is on what [14] page?

[15] A: Six.

[16] Q: As well as – you wrote the portion right [17] under basis for opinion number 3?

[18] A: Yes. But there again if you look at [19] standard 14 conceptually some of that information [20] that comes out of the standard –

[21] Q: Okay. Right now I am just asking you [22] whether or not you wrote these words – let me [23] rephrase that. The statement of opinions, the [24] first opinion that you received is marked as Coiner

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[1] Deposition Exhibit No. 3; is that correct?

[2] A: The July 24th, 1997, fax?

[3] Q: Yes. You didn't write this; is that [4] correct?

[5] A: I did not type that.

[6] Q: Did you handwrite that?

[7] A: No. It's based on a telephone [8] conversation between Marybeth and myself.

[9] Q: Please answer my questions, you didn't [10] type –

[11] MS. CYZE: Excuse me, he just answered that.

[12] MR. GORDON: I don't want him volunteering what [13] you have coached him to say. We went through this [14] with your last witness, I don't want to have to go [15] through this again.

[16] BY MR. GORDON:

[17] Q: My question was, you didn't write these [18] opinions on Deposition Exhibit No. 3 either by hand [19] or by having them typed did you?

[20] MS. CYZE: I will object to the form of the [21] question. He said that he did write them, it's the [22] way that you are using the term write, are you [23] saying prepared, are you saying draft –

[24] MR. GORDON: He just testified that he didn't

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[1] write them.

[2] MS. CYZE: Are you saying cursive, are you [3] saying typed are you saying – you're attempting to [4] twist this.

[5] MR. GORDON: No, I am not. Look I don't mind [6] if you write their opinions for them, I would just [7] like them to answer the questions.

[8] BY MR. GORDON:

Did you take a pen or a pencil or a writing implement and write down at appears on [11] Deposition Exhibit ?

: No.

Q: Did you dictate for someone else e [14] what is found on Deposition bit No. 3?

A: Yes.

: Okay. What did you dictate it in to?

: I dictated it, and I am using the m [18] dictate to cover the conrsation that Marybeth and [19] I had, ook notes from this conversation.

: Have you seen her notes?

A: No, I haven't.

: So you don't know whether she notes [23] do you?

A: I would have to believe based what

she returned to me that she would had to.

Do you know whether she took es?

I don't know whether she took .

Q: Well, all you know is you talked to [15] is that correct?

That's correct.

Q: All right. And then she sent you [8] position Exhibit No. 3; is that correct?

Yes.

. Okay. Now, after you received position [11] Exhibit No. 3 did you call

Yes.

Q: And what did you say to her?

A: I indicated to her that I would be ng [15] to refine those opinions.

Q: Anything else?

A: Essentially that's it.

And then what did you then do to [19] those opinions?

A: I took the opinions and developed you [21] see here as the expert t.

Q: All right. How many drafts were re of [23] the statement of opinions en Deposition [24] Exhibit No. 3 eposition Exhibit No. 1?

don't know.

Approximately how many?

A: Approximately three.

Okay. With respect to just the nent [5] of opinions the first draft uld have been [6] Deposition Exhibit 3?

[7] A: Yes.

[8] Q: And the last draft would be Deposition [9] Exhibit No. 1?

[10] A: Yes.

[11] Q: All right. Where is the middle draft?

[12] A: I did not keep copies of any of that.

[13] Q: Were you instructed not to keep copies?

[14] A: No, I was not.

[15] Q: Well, tell me about the second draft is [16] this something that you wrote out in hand just [17] referring now to the statement of opinions?

[18] A: The statement of opinions it's my [19] recollection that I did type that up.

[20] Q: What type of word processing program do [21] you have at your office?

[22] A: It's Word Perfect.

[23] Q: Was this typed on Word Perfect?

[24] A: Yes, I believe so.

[1] Q: Did you type it or did your secretary?

[2] A: I would have typed it.

[3] Q: And after you typed it what did you do?

[4] A: I sent it to Marybeth.

[5] Q: In what manner?

[6] A: Fax, that would have been by fax.

[7] Q: Was that a fax directly off your computer [8] or a printout?

[9] A: It would have been a printout and faxed.

[10] Q: Okay. Did you delete what you typed?

[11] A: That I am not sure. I routinely delete, [12] but I am not sure.

[13] Q: I'd like a copy of whatever if that still [14] exists.

[15] A: Okay.

[16] Q: All right. When you did your draft which [17] you then faxed to her how many opinions did you [18] have?

[19] A: We still had all four items at that [20] point – or excuse me, five items at that point.

[21] Q: Can you tell me why some of the items were [22] later dropped?

[23] A: Item five, a statement of fact as opposed [24] to an opinion, item 3 –

[1] Q: Well, item number five for instance is a [2] true statement of fact?

[3] A: That is a true statement of fact in that [4] there are manufacturers of copper pipe that have [5] received certifications against ANSI NSF standard [6] 61.

[7] Q: Do you know what that number was?

[8] A: The number ended up being two.

[9] Q: And the only that was deleted was because [10] it was an opinion it wasn't a statement of fact?

[11] A: Yes.

[12] Q: Okay. What else was dropped?

[13] A: Item three.

[14] Q: Why was that deleted?

[15] A: My understanding is that B.F. Goodrich was [16] exploring having NSF do some work on the antifreeze [17] solution and at the time of the expert report B.F. [18] Goodrich had not acted on that.

[19] Q: So has there been no NSF study on the risk [20] to human health of antifreeze solutions during [21] hydrostatic testing?

[22] MS. CYZE: I am just objecting, NSF doesn't do [23] studies, so it's just a technical term.

[24] MR. GORDON: Did I say study or –

[1] MS. CYZE: I think that's a big confusion [2] here.

[3] MR. GORDON: I am just not sure whose confusion [4] it is.

[5] BY MR. GORDON:

[6] Q: Has NSF done any work with respect to the [7] effect on human health of antifreeze solution used [8] during hydrostatic testing of CPVC products?

[9] A: No, we have not.

[10] Q: So you can't then give an opinion as [11] stated in number 3; is that correct?

[12] A: Yes.

[13] Q: Let's go to your first – strike that. [14] Let's go to the first statement of [15] opinion, I am talking about the first one on [16] Deposition Exhibit No. 3.

[17] A: Okay.

[18] Q: The first opinion that was provided in the [19] document faxed to you by Marybeth on July 24th, [20] what was it about that statement that caused you to [21] want to modify it?

[22] A: It's essentially not written in the [23] language that NSF normally would use. The two [24] statements are essentially equivalent.

[1] Q: All right. Sitting here today is it your [2] opinion or do you have an opinion as to whether or [3] not there is a risk to human health associated with [4] drinking potable water distributed through CPVC [5] ASTMD 2846?

[6] A: There is not.

[7] Q: And what do you base that opinion on?

[8] A: I base that on ASTM 2846 requiring that [9] products complied with ANSI NSF standard 61 and an [10] understanding of how that standard works. That [11] product complying with those standards is not going [12] to put any contaminants into the water at levels [13] that would cause a risk to human health.

[14] Q: And by contaminants what do you mean?

[15] A: Essentially I believe I am using the word [16] contaminant the way you were using the word [17] leaching.

[18] Q: I am asking what type of things?

[19] A: Typically we would look at regulated [20] metals, phenolics, VOCs, RVCM, and any other [21] potential contaminants that are there based on a [22] review of the formulation of the materials that are [23] being used in the product.

[24] Q: What's an RVCM?

[1] A: Residual vinyl chloride monemor.

[2] Q: All right. VOC is what?

[3] A: Volatile organic compound.

[4] Q: Okay. Such as?

[5] A: A good VOC would be acetone, and that's [6] not one that we would normally look for in CPVC, [7] but that's an example of something that would be a [8] volatile organic.

[9] Q: What's a phenolic?

[10] A: It refers to a type of chemical compound.

[11] Q: Okay. And when we're talking about metals [12] we're talking about lead?

[13] A: You're talking about any of the regulated [14] metals, you're talking about lead, copper – it's a [15] whole laundry list, zinc.

[16] Q: Referring to Deposition Exhibit No. 1, [17] opinion 1, you say that in the first sentence that [18] CPVC piping plan manufacturers to the requirements [19] of ASTMD 2846 and intended in use of drinking water [20] application is required to meet the requirements of [21] ANSI/NSf standard 61, is it possible to purchase [22] CPVC piping that's not manufactured to those [23] standards?

[24] A: Yes. There are other ASTM standards and

[1] other product standards that relate to CPVC piping.

[2] Q: Can I buy CPVC piping that doesn't meet [3] any ASTM or NSF standards?

[4] A: It's possible, I don't know how probably [5] it is.

[6] Q: Well, assuming that these things are [7] perhaps manufactured outside the United States [8] there is nothing – do you know of anything that [9] prohibits the importation of CPVC pipe that doesn't [10] meet ASTM and NSF standards?

[11] A: I would think that the building codes for [12] instance the national codes from organizations like [13] Boca, ICBO, and Southern would present a barrier to [14] that happening.

[15] Q: I wasn't talking about installation, I was [16] talking about importation?

[17] A: They require the product to be certified [18] as meeting certain standards.

[19] Q: Before they're imported?

[20] A: Before they're installed and accepted.

[21] Q: Are you aware of any rule or law or [22] regulation that prohibits the importation of CPVC [23] pipe which doesn't meet ASTM or NSF standards?

[24] A: No, I am not.

[1] Q: Okay. Is it possible that improperly [2] installed CPVC piping which meets the standard 61 [3] requirements will result in the addition of [4] contaminants at levels exceeding the EPAs maximum [5] contaminant levels?

[6] A: NSF does not address installation, our [7] standards are designed to talk about the specific [8] properties of the products themselves, not [9] installation.

[10] Q: So you can't answer my question?

[11] A: Correct.

[12] Q: Is it possible for instance if you use too [13] much of a solvent cement in joining CPVC pipes and [14] fittings that contaminates might be introduced into [15] the water as a result?

[16] A: I think it may be probable, but it's [17] certainly probable regardless of the type of [18] drinking water contact product you're talking [19] about. Whether you're talking about any other [20] system it's not anything that is unique to CPVC [21] solvent cement. Proper installation is not a [22] unique aspect of these products.

[23] Q: Do you know if THF can be hazardous to [24] human health?

[1] A: From the standpoint that any product, any [2] chemical potentially can in the right dosage be a [3] health issue – I am not sure I understand the [4] context of the question, are you looking for a [5] particular dosage, I am not sure what you mean.

[6] Q: I am asking you whether under any [7] cicumstances THF can be harmful to human health?

[8] A: The extent of my knowledge is that there [9] is a maximum allowable limit set for THF in [10] drinking water.

[11] Q: Do you know what that is?

[12] MS. CYZE: Objection, Mr. Coiner is not here as [13] a toxicologist nor has he provided any information [14] to suggest that he is a toxicologist knowing [15] anything about dosages and exposures and risk [16] assessments. so I think it's outside the purview of [17] the opinions that he has provided here.

[18] MR. GORDON: Well, I think it's exactly within [19] the purview of his opinions. You folks have [20] submitted an expert report signed by this man who [21] says that if you use this stuff properly it's not a [22] health problem and my question to him is if you use [23] it improperly is there a health problem.

[24] MS. CYZE: He answered that question, that's

[1] not your last series of questions.

[2] MR. GORDON: I asked –

[3] MS. CYZE: You're talking now about the [4] toxicological effect of the chemical.

[5] MR. GORDON: He said there is a maximum [6] allowable limit for THF in drinking water I asked [7] him if he knows what that is.

[8] MS. CYZE: Now we're starting to go down the [9] line which is well beyond his opinions here in [10] terms of toxicological information, he's not a [11] toxicologist.

[12] BY MR. GORDON:

[13] Q: Do you know what the maximum limit for THF [14] in drinking water is?

[15] A: I would have to look that up.

[16] Q: As you sit here today you don't know what [17] it is?

[18] A: I'd be going from memory, I believe it [19] is – I'd be going from memory.

[20] Q: Okay. Do you know what cyclohexanone is?

[21] MS. CYZE: Same objection.

[22] BY MR. GORDON:

[23] Q: Do you know what that is?

[24] A: It's a solvent.

[1] Q: Do you know if in the right dosage it [2] could be harmful to human health?

[3] MS. CYZE: Same objection.

[4] BY MR. GORDON:

[5] Q: You can answer.

[6] A: I am not a toxicologist and it sounds like [7] you're looking for a toxicologist's opinion.

[8] Q: I am just asking you whether you

w if [9] it could be harmful to human
ealth?
)] A: Yes.
Q: Do you know whether it could be
...nful to [12] human health in the right
)sage?
A: Again the other answer I can give
is [14] the answer that I gave you
efore in terms of it's [15] my under-
anding any chemical that you could
e [16] in contact with or any material
he right [17] exposure, but this is
tting outside of my area of [18] ex-
rtise.
Q: Are you aware of any studies
...rding the [20] effects of THF or
clohexanone on the health of [21]
...an beings?
A: Yes.
Q: And what studies are those?
A: There's a –

MS. CYZE: Could you read that an-
... back.
(Whereupon, the record was read.)
THE WITNESS: Then my answer is
correct, I [4] don't know of any studies
ifically on humans.
BY MR. GORDON:
Q: Okay. Do you know what amor-
...ilica is?
MS. CYZE: Same objection.
THE WITNESS: It's obviously an in-
edient in [9] the product that you are
ing.
BY MR. GORDON:
Q: Okay. You don't know what it is.
[12] don't have to know answers to all
ny questions [13] this is just an
)portunity for me to know what you
know or find out what you know.
: It's an ingredient in the particular
)rmulation that you are looking at.
Q: You knew for instance that cyc-
...xanone [18] was a solvent, you don't
v what amorphasilica is [19] do you?
A: It's amorphasilica, it's what it is. Do
you know what silica is, silica sand?
: I know what sand is, what's amor-
ilica?
A: I don't know how to describe it to
[24] Amorphasilica is amorphasilica.

Q: What do you use it for?
I am not sure what it's uses are.
Okay. How about methyl ethyl
ytone do [4] you know what that is?
A: That's a solvent.
And would it be your under-
...ding that in [7] the right dosage that
thyl ethyl keytone could be [8] harm-
ful to human health?
[9] A: Again I am not a toxicologist, this is
[10] outside my area of expertise.
[11] Q: So the answer is no?
[12] A: Yes.
[13] Q: Is it possible for me to purchase
cements [14] that will join two pieces of
CPVC pipe or pipe and [15] fittings which
does not meet an ASTM or NSF [16]
standard?
[17] A: That I don't know, I would find it
[18] improbable.
[19] Q: Let me show you what has been
previously [20] marked as Deposition
Exhibit 6 which is a container [21] of
Oatey CPVC cement, and if you look at
the lower [22] right hand corner of the
front of the label do you [23] see an ASTM
designation?
[24] A: Yes.

[1] Q: And that's ASTM F-493?
[2] A: Yes.
[3] Q: I am going to show you what been
marked as [4] Deposition No. 16 which is
a container of Oatey [5] CPVC cement,
and isn't it correct that the label on [6]
this in the lower right hand corner says
that this [7] meets the ASTMD 2564
standard?
[8] A: Correct.
[9] Q: I am now going to show you what
has been [10] marked as Deposition
Exhibit No. 7 which is a [11] container of
Oatey all purpose cement, I wonder if [12]
you can show me where the ASTM
designation is on [13] that label?
[14] A: To my knowledge there is not –
there does [15] not exist an ASTM stan-
dard for this type of [16] product.
[17] Q: Or an NSF standard?
[18] A: This is a product that could be
evaluated [19] under standard 61.
[20] Q: Has it been?
[21] A: The container that you have hand-
ed me does [22] not have an NSF cer-
tification mark on it, my [23] assumption
would be, no, it hasn't, but that's an [24]
assumption based on the label.

[1] Q: So we would have no way of
knowing whether [2] this container, Dep-
osition No. 7, meets any NSF or [3] ASTM
standards would we?
[4] A: It's public information, it's avail-
able on [5] the internet, you could look up
the Oatey listing.
[6] Q: You said that it's impossible that
you [7] could – I thought you said it was
impossible that [8] you could buy a
cement that joins CPVC that does [9] not
meet any ASTM or NSF standard.
[10] A: I don't recall that, that's not what I
[11] said.
[12] Q: So it's your testimony that we
could?
[13] A: My testimony was that in the
context of [14] your question which was
specifically could I go out [15] and buy a
CPVC cement that doesn't comply or is
not [16] made to any standards, and my
response to that was [17] that I would find
that improbable. And just for [18] clar-
ification when I talk about CPVC ceme-
nts I am [19] taking it in terms of the
product that you first [20] showed me
which is made to ASTM standard F-493
[21] that's a CPVC cement. The last
exhibit that you [22] handed me is not a
CPVC cement, it's an all purpose [23]
cement. That is not what I would typ-
ically think [24] about as a CPVC cement.

[1] Q: And why is that?
[2] A: Simply because with those pro-
ducts there [3] is not an ASTM per-
formance standard so that in my [4]
experience working with these pro-
ducts it's not a [5] product that I would
deal with directly.
[6] Q: Well, have you ever seen products
on the [7] shelf at hardware stores such as
this Oatey all [8] purpose cement?
[9] A: It's possible that I have. I have been
[10] very fortunate in that I haven't
installed any mild [11] plumbing will so I
haven't had to buy any cement.
[12] Q: As I understand your testimony
you don't [13] think of this as a CPVC
cement because it doesn't [14] have an
ASTM number on it?
[15] A: No, that's not what I said. I said that
[16] that's an all purpose cement. To me
sitting here [17] Ron Coiner is not a CPVC
cement, it's an all [18] purpose cement.
And then additionally for a [19] product
that is an all purpose product or is being
[20] marketed as an all purpose product
there is not an [21] ASTM standard that
specifically speaks to the [22] per-
formance of that product.
[23] Q: Will this product join CPVC pipe
to a CPVC [24] fitting if you know?

[1] MS. CYZE: Objection, you are way
beyond his [2] testimony here. You're
asking him to be an expert [3] as to what
are the appropriate cements for the [4]
appropriate pipes and I don't believe
that there is [5] anything that he has
testified to so far that would [6] give
indication that he knows that in-
formation.
[7] BY MR. GORDON:
[8] Q: Do you remember the question?
[9] A: No.

(Whereupon, the record was read.)

BY MR. GORDON:

Q: I will rephrase it if you don't understand it, Deposition Exhibit No. 7 is a can of Oatey all purpose cement, do you know if this all purpose cement will join a CPVC pipe to a CPVC fitting?

A: I have never seen that product before, I have no basis for an opinion.

Q: Okay. Let me ask you this: Mr. Coiner, what did you do to prepare for your deposition today, not what did you do today, but what did you do to prepare for the deposition?

A: Sat down and reread my expert report, read the standards or reviewed them, and then I had a meeting yesterday with Marybeth.

Q: How long did you meet yesterday?

A: 2:45 until 6:30.

Q: And what did you do in those nearly four hours?

A: We reviewed the expert report, discussed the standards.

Q: Anything else?

A: No.

Q: Did you have a practice question and answer session?

A: She did some preparation work in terms of questions.

Q: Did she give you sample questions?

A: I wouldn't call them sample questions.

Q: Well, what did she do?

A: She asked questions about the expert report.

Q: And then did you give answers?

A: Well, they weren't really questions, it was more general comments.

Q: She went through the report and made general comments about the report?

A: And –

MS. CYZE: Objection, that's a

mischaracterization of his testimony.

THE WITNESS: I don't know how else to describe it, we sat down and went through the expert report.

BY MR. GORDON:

Q: Line by line?

A: I don't think we specifically sat down and went line by line, no.

Q: Okay. Did she ask you questions that she thought that you would be told the type of questions that you would be asked during the deposition?

A: She did ask questions, yes.

Q: And when you gave your answers did she then critique your answers?

A: I wouldn't call it critiquing, we discussed the answers.

Q: Did you discuss ways that your answers could be improved upon?

A: Not really, no.

Q: What did you discuss when you discussed the answers?

A: In context of the opinions and the standards.

Q: Can you explain to me what you mean by that?

A: I am not sure – I am not sure I follow what you're asking.

Q: Well, you spent almost four hours with her, I want to know what you did during the four hours. You've told me that she asked questions and you gave answers, I want to know after you gave the answers did you discuss your answers?

A: That was a small portion of what we did.

Q: So the answer is yes, but it was a small portion of what you did?

A: Yes.

Q: Okay. And when you discussed your answers were suggestions made as to how your answers could be better?

A: No.

Q: Did you have discussions on how your answers could be modified?

A: No.

Q: When you discussed your answers what types of things did you discuss?

A: We discussed how to give direct answers, paying attention to the question, not leading the

question. I found it to be very basic.

Q: Did you discuss anything relating to your saving of drafts?

A: No. She did ask for my file.

Q: Is there anything else that you recall discussing during the three hours and 45 minutes?

MS. CYZE: I don't think you've established that we had discussions for three hours and 45 minutes.

MR. GORDON: Well, he told me you met from 2:45 to 6:30, so I did the math.

MS. CYZE: But he may have been in my office, I don't think that you've established that him and I talked the entire time.

MR. GORDON: I think his testimony is what his testimony is. He said you were together from 2:45 to 6:30, I assume that was to prepare for your testimony here.

BY MR. GORDON:

Q: What else did you do during the time that you spent with her?

A: She had at least one phone call, I had at least one phone call that I made and we had taken breaks.

Q: What else did you do with respect to preparing for your testimony?

A: That was it.

Q: Did you discuss answers to questions that might be asked of you with respect to how the expert report was prepared?

A: We did talk about the preparation of the expert report.

Q: And what was said by Marybeth?

A: We simply reviewed how we put that report together.

Q: When did you first see a version of the report that contained the materials on pages 1,2,3,4,5, and 6 starting with the word introduction?

A: Are you asking me when I first specifically saw the report with that information on it?

Q: Yes, sir.

A: That would have been the day before I signed it I believe, so that would have been the last day of July if I am not mistaken.

Q: Okay. And how was that document transmitted to you?

A: By fax.

Q: Did you make any modifications to the portion of the document starting with the word introduction before you signed it?

A: We have established that there were drafts in between, so I am not sure what point in time you are asking about.

Q: Well, we have the first draft, that's Deposition Exhibit No. 3, we have the final draft which is Deposition Exhibit No. 1, which draft had the portion of the report starting with the word introduction?

A: That I am assuming would be – and again like when I answered the question about the number of drafts that was to the best of my recollection. I am assuming it's that draft in between or one of the drafts in between.

Q: So you first saw a draft with the [19] introduction portion on draft number two?

A: I am not positive whether it was [21] number two or if there was a subsequent draft.

Q: What I am trying to get at, Mr. Coiner, is [23] the portions of your report under the heading: [24] Basis and Reasons for Opinions Nos. One and Two,

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who took the materials out of the NSF standards to [2] include into your expert report?

A: I did.

Q: You did that orally?

A: Yes, with Marybeth.

Q: Did you go through line by line?

A: We went through section by section which [8] depending on the section I have been paragraph by [9] paragraph.

Q: Have you kept time records of the [11] that you have spent on this?

A: I have kept records from the time that I [13] became involved in late July.

Q: Where are those records?

A: Those would be back in my office.

Q: I think those should have been produced.

A: I didn't realize that that was part of the [18] file.

Q: It's not your job to realize it. [20] Did you go through this portion of the report, Basis and Reasons for Opinions One and Two, [22] on the phone with Marybeth?

A: Yes, we discussed that over the phone.

Q: And did you have a copy of standard 61 in

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front of you?

A: Yes.

Q: And you and Marybeth went through standard [4] 61 and decided what to put into the report?

A: Yes.

Q: Is the same true with respect to the portion of the report starting on page

A: Yes.

Q: You used the same procedure on the phone?

A: I believe so, yes.

MR. GORDON: I am through asking those [12] types of questions, do you want to take a break [13] otherwise I will keep going, I don't care?

MS. CYZE: No break, but just I would prefer [15] while he is sitting here to clear up what his last [16] answer was.

[17] EXAMINATION

[18] BY MS. CYZE:

[19] Q: In terms of the numbered paragraphs one [20] and two here who wrote those?

[21] A: I wrote those.

[22] Q: And page 6, the line basis for opinion [23] number three, who wrote those?

[24] A: I wrote those.

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[1] Q: And again can you take a look at [2] everything starting from the title down and can you [3] tell me who wrote those?

[4] A: I wrote those and I believe I have already [5] said that.

[6] MS. CYZE: I don't have any other questions.

[7] MR. GORDON: How long do you want to break [8] for?

[9] MR. CYZE: Half hour.

[10] (A short break was taken.)

[11] MR. GORDON: Can you mark this please.

[12] (Whereupon, COINER Deposition [13] Exhibit Nos. 4 & 5 were marked [14] for identification.)

[15] EXAMINATION

[16] BY MR. GORDON:

[17] Q: Mr. Coiner, I am showing you what has been [18] marked Deposition Exhibit No. 4 which [19] is - Mr. Coiner this morning you provided me with [20] this NSF tetrahydro furan meeting minutes of July [21] 10, 1997, were you present at that meeting?

[22] A: Yes, sir.

[23] Q: In what capacity?

[24] A: I was there as the general manager of the

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[1] plumbing and related programs at NSF.

[2] Q: What was the purpose of the meeting?

[3] A: The purpose of the meeting was to discuss [4] with the individuals present, the acceptance [5] criteria for THF.

[6] Q: Why was this material provided to me [7] today?

[8] A: I believe it was provided to you because [9] it was information that I reviewed as part of the [10] preparation for today's deposition.

[11] Q: As a result of your participation at this [12] meeting did you learn anything that indicates that [13] THF might under certain circumstances pose a health [14] risk to humans?

[15] A: No, I didn't.

[16] Q: Is there a THF MAL?

[17] A: Yes.

[18] Q: And is there consideration being given to [19] modifying a procedure for testing THF, testing for [20] the presence of THF?

[21] A: The test procedure is not under review.

[22] Q: What is under review?

[23] A: The MAL is under review, and under review [24] may actually be too strong of a term.

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[1] Q: Well, you can give it whatever term you [2] want. I am reading here it says: The MAL process [3] is being redesigned so there is input from all of [4] the stake holders involved when high impact MALs [5] are being developed.

[6] Let's start with the basics, what is an [7] MAL process?

[8] A: The development of an MAL is the [9] establishment of a maximum allowable limit for a [10] contaminant in drinking water. And the process [11] basically falls down to two categories, one is if [12] the contaminant of interest is a regulated [13] contaminant verse a potential contaminant that's [14] unregulated. And part of NSF's responsibility [15] under standard 61 is to set MALs, that's one of the [16] roles that we fulfill.

[17] Q: Okay. And why is the MAL process for THF [18] being redesigned?

[19] A: The process is not being redesigned [20] specifically for THF, the process itself is being [21] redesigned from the standpoint of the establishment [22] of a health effects task crew to review MALs and [23] our MAL department to provide some additional [24] oversight to our process. And at the same time

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[1] we're looking at THF and the current MAL for THF.

[2] Q: Are you looking at lowering or increasing [3] the maximum allowable level?

[4] A: At this point there is not enough [5] information available to really make that decision [6] as to what would happen with the MAL. One of the [7] purposes for the meeting was to establish what [8] additional information would be necessary.

[9] Q: All right. What is a stake holder?

[10] A: The stake holder is a term that is used by [11] our standards department to refer to any interested [12] party, and those typically fall into three [13] categories that I think I have mentioned earlier [14] today. Regulatory officials,

product users, and [15] product manufacturers. Collectively those would be [16] the stake holders.

[17] **Q:** Was there anybody present at this meeting [18] other than NSF personnel?

[19] **A:** Yes.

[20] **Q:** Who was there?

[21] **A:** There were representatives of the THF [22] industry, representatives of the solvent cement [23] industry, and a representative from EPA.

[24] **Q:** What's a high impact MAL?

[1] **A:** High impact MAL is an MAL that potentially [2] has a rather broad effect or will effect a large [3] number of products or also an MAL that somehow has [4] some significance attached to it in terms of the [5] amount that the MAL could change. As opposed to a [6] low impact MAL which eventhough there's a need to [7] set the MAL from the standpoint of people being [8] interested in it there is just not a lot of [9] interest in it.

[10] **Q:** Now, attached to the draft meeting minutes [11] is a memorandum dated June 27, 1997, by David [12] McFaden, he is the toxicologist; is that correct?

[13] **A:** He is the director of risk assessment.

[14] **Q:** Is he a toxicologist?

[15] **A:** He is a toxicologist.

[16] **Q:** And he is an NSF toxicologist?

[17] **A:** He is employed by NSF, yes.

[18] **Q:** And he wrote in his report: As I [19] expected, I did not find any large long term [20] epidemiological studies on THF. [21] Is that correct?

[22] **A:** That's correct.

[23] **Q:** Sitting here today you're not aware of any [24] long term epidemiological studies on THF are you?

[1] **A:** Based on the available information there [2] does not appear to be any long term epidemiological [3] studies on THF.

[4] **Q:** Would that indicate then that we don't [5] know what effect THF would have on human beings?

[6] **MS. CYZE:** Objection.

[7] **MR. GORDON:** I will withdraw the question.

[8] **BY MR. GORDON:**

[9] **Q:** Now, Mr. McFaden wrote in the last [10] paragraph in his memorandum that certain points [11] that he made in the memorandum: Indicate that the [12] liver is target organ for THF in humans.

[13] Did he not?

[14] **A:** Yes.

[15] **Q:** Now, referring to Deposition Exhibit No. 6 [16] which is OTC CPVC cement, do you see that the first [17] ingredient listed on the can is THF?

[18] **A:** Yes.

[19] **Q:** That's the THF referred to in [20] Mr. McFaden's report; is that correct?

[21] **A:** Yes.

[22] **Q:** Would you think that an installer using [23] OTC CPVC cement with THF would be exposed during [24] the installation process to THF?

[1] **A:** I am not qualified to answer, it's not my [2] area of expertise.

[3] **Q:** What is a TLV?

[4] **A:** That is a terminology that is related to [5] inhalation I believe. I am not familiar [6] specifically with that term - actually I do not [7] recall what it means.

[8] **Q:** Good.

[9] **A:** Threshold limit value.

[10] **Q:** Do you know what that means?

[11] **A:** I don't know, I am surprised that I [12] remembered that after all of these years.

[13] **Q:** Also attached to this report is a series [14] of pages taken from a source I do not know on THF, [15] do you see that?

[16] **A:** Yes.

[17] **Q:** See at the bottom lower left corner [18] there's human studies.

[19] **A:** Yes.

[20] **Q:** Have you read this?

[21] **A:** I have read this.

[22] **Q:** Okay. So circulated among you folks at NSF [23] was a document that indicated various symptoms [24] experienced by people who came in contact with THF;

[1] isn't that correct?

[2] **MS. CYZE:** I haven't had a chance to read this [3] and I don't know if he has read it to say that this [4] necessarily describes symptoms of people who have [5] come in contact with THF.

[6] **MR. GORDON:** I am asking him to look at it.

[7] **MS. CYZE:** You're asking him now to read [8] that?

[9] **MR. GORDON:** Yes. Read it and take his time.

[10] **THE WITNESS:** Could you restate the question.

[11] **BY MR. GORDON:**

[12] **Q:** Sure. [13] There was a document circulated among the [14] staff of the NSF which indicated that THF in [15] certain studies has had an effect on the health of [16] persons; isn't that correct.

[17] **MS. CYZE:** Objection.

[18] **MR. GORDON:** I will rephrase it.

[19] **BY MR. GORDON:**

[20] **Q:** This document was circulated among staff [21] members at NSF; is that correct?

[22] **A:** Yes.

[23] **Q:** And you're one of those people?

[24] **A:** Yes.

[1] **Q:** This document indicates for instance that [2] exposure to THF has been reported to be irritating [3] to skin, eyes, and mucus membranes; isn't that [4] correct?

[5] **A:** Yes. I do see references to that, [6] however, this document is referring to inhalation.

[7] **Q:** I am not talking about drinking water with [8] THF in it, I am talking about using products which [9] you tell me meet the NSF standard, the Oatey CPVC [10] cement, Deposition Exhibit No. 7 has the NSF mark [11] on it does it not?

[12] **A:** Correct.

[13] **Q:** All right. And that product contains THF; [14] isn't that correct?

[15] **A:** Correct.

[16] **Q:** And one of the documents that you folks [17] have at NSF indicates that THF has been reported to [18] be irritating to the skin, eyes, and mucus [19] membranes; isn't that correct?

[20] **A:** That's correct.

[21] **Q:** Thank you, you answered that question. [22] This document also indicates that a worker in a [23] confined space using methalethel keytone, MEK, [24] wound up having effects on the peripheral nervous

[1] system; isn't that correct?

[2] **A:** Again I want to state that this is talking [3] about an inhalation exposure, that is not our area [4] of expertise. Standard 61 addresses contaminants [5] in drinking water not worker exposure. I can sit [6] here and repeat to you what is in the document, but [7] in terms of an opinion I am not qualified to give [8] you an opinion on worker exposure.

[9] **Q:** When you say worker exposure you're not [10] qualified to give us an opinion -

[11] **A:** Inhalation.

[12] **Q:** Or contact with the skin, too?

[13] **A:** Inhalation, dermal exposure.

[14] **Q:** And you're not qualified to give me an [15] opinion on whether or not worker exposure to THF [16] can be harmful to that person's health; isn't that [17] correct?

: Correct.

Q: Then your opinions in this case e only related to what may or may happen to a person who is king water that goes through CPVC pes and fittings. It has nothing at all do with what might happen to e who install a CPVC system; is correct?

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I am not sure in terms of the way phrased that question, but my tement of opinions I think are very r in that what I am talking about is inking water exposure and not a ker exposure be it inhalation or rmal.

If you were to be provided with a tific study demonstrates that chemals or compounds may leach from VC potable water systems into the r is it possible that that would cause ou to reevaluate your opinions one d two assuming that that system installed consistent with a system erly installed where the components of the system meet the requirents of NSF 61; did you understand question?

: Can I repeat it to you and make e that I understand it?

Q: Yes.

: What I understood was you asked presented me with a study that d there are chemicals that leach f a CPVC piping in the drinking r would that change my expert rt assuming that the products re properly installed.

: And the products met NSF 61 lard?

A: Based on that question my answer uld be,

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no, because we have already estabhed that there are things that leach f CPVC piping or any other water act material or component. If ere weren't things that came out of ter contact components be they be PVC or copper there would be ed for standard 61 or the drinking water regulations for that matter. So at principal has already been eshed there are things that come n drinking water from the water ntact materials.

Q: If the compound or chemical that ound to be leaching out of CPVC le water piping was a chemical compound that is known to be mful to human health would that ge your opinion?

A: It would depend on the level at ich that contaminant was extracting out into the water, and whether or not that contaminant was extracting out into the water at a level that exceeded the MAL for that contaminant.

Q: If it exceeded the MAL it might provide a basis for you changing your opinion?

A: It would not provide a basis for changing my opinion because that would be a product that would not be certified against ANSI NSF 61. It

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could not comply with ANSI NSF 61 if it did not meet the chemical extraction requirements.

Q: I think I understand. Has your experience of MALs changed?

A: MALs can change. It's certainly a dynamic world that we live in, things change over time. There is additional information that becomes available, additional studies, research, and that actually is one of the roles again that we serve under standard 61 as a standards development organization is to develope and maintain the MALs.

Q: The standards that NSF has developed specifically standards 14 and 61 those standards are not intended to address all of the potential problems that you may have that one might encounter from using CPVC product?

MS. CYZE: Objection, I don't think he has testified as to any potential problems in using CPVC, do you want to be specific and tell him assuming x is a problem does NSF address that.

BY MR. GORDON:

Q: Well, I will rephrase it. NSF standards 14 and 61 are limited in scope in terms of the fact that they just address product composition and

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certain performance characteristics; isn't that correct?

A: That's not correct.

Q: Well, they don't address worker installation health problems do they?

A: That's a correct statement.

Q: Are you aware of any standards that do address worker health problems in dealing with CPVC?

A: There is. OSHA I believe in the United States which is the agency that is responsible for workplace safety.

Q: Are you aware of any standards?

A: That's not an area that I work in, I have no idea.

Q: Are you aware of any states that have standards for the installation of CPVC products in terms of worker health?

MS. CYZE: Objection, he stated several times that worker health is not anything he deals with nor does NSF deal with nor do any of his opinions come close to dealing with worker health.

BY MR. GORDON:

Q: In your report – I will withdraw the

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question, in your report you refer to something called DMF.

A: In which report?

Q: I think it's in your expert report.

A: I am familiar with DMF.

Q: What is DMF?

A: It's a solvent.

Q: Do you know what it is used for?

A: At one time it was used in solvent cements.

Q: And now?

A: It is no longer accepted in those products.

Q: And why is that do you know?

A: Additional information became available that indicated that the solvent was no longer acceptable.

Q: From a health standpoint?

MS. CYZE: Objection, again you're going into toxicology areas regarding solvents that are well beyond this report and Mr. Coiner's expertise.

THE WITNESS: And I don't know the specifics.

BY MR. GORDON:

Q: At one time was there an MAL for DMF?

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A: That I don't know, that actually goes back a number of years before my direct involvement.

Q: But the elimination of DMF – strike that. A little while ago you said that this is a dynamic world that we live in, additional studies and research are made so we review those in developing MALs and standard 61, is the record of DMF an example of additional information coming in so that positions were changed.

MS. CYZE: Objection, I don't believe that he has indicated that he has reviewed any record of DMF or that he is qualified to discuss DMF.

MR. GORDON: He did say that it's no longer accepted because additional information became available.

MS. CYZE: I don't believe that he was definitive.

MR. GORDON: The record is what it is.

BY MR. GORDON:

Q: Now, is that an example of the response that is made when additional information comes in and products are reevaluated?

A: Not being a toxicologist the only thing that I can tell you is that DMF is not allowed by

policy in products.

Q: Does the NSF evaluate sotter used in joining pieces of copper?

A: It would be evaluated against standard 61.

Q: Do you have any knowledge about the evaluation of sotter?

A: No, I do not.

Q: All right. Referring to page two of your report, general requirements, standard 61, can you read that first paragraph to yourself, please.

A: Yes.

Q: An RVCM is what?

A: As I previously stated that is residual vinyl chloride monomer.

Q: Where is that found?

A: That is found in vinyl piping products which would be inclusive of CPVC and PVC.

Q: Is there an MAL for RVCM?

A: There is acceptance criteria, I am not sure that it is actually considered to be an MAL because by the standard it's tested not in the extracted water but in the wall of the pipe or fitting so it's actually a test that looks at how much residual is actually in the product as opposed

to how much is coming out of the water.

Q: Is it something that can come out in the water?

A: It's something that certainly could come out in the water.

Q: Do you folks test products to see how much RVCM may come out in the water?

A: We're looking again at standard 61 looks at for RVCM the amount of residual vinyl chloride in the product wall.

Q: So the answer is you don't test to see how much may leach out into the water?

A: The research has been done for that even prior to standard 61 and again not being a toxicologist I can't speak directly to a lot of those issues.

Q: Are you telling me that you don't know whether that something –

A: I know that there has been extensive work done on residual vinyl chloride, in fact, it is one of the most heavily monitored substances from the standpoint of our certification program that you are going to find.

Q: But my question is: Are you aware of any

study that determine whether or not RVCM leaches out of plastic pipe into water?

A: Not specifically.

Q: Do you know whether RVCM has been as a result of any study determined to be harmful to human health?

MS. CYZE: And I object as to it's a toxicology question.

THE WITNESS: And again my answer is I am not a toxicologist.

BY MR. GORDON:

Q: So the answer is you don't know?

A: I don't know.

Q: Can you turn to page three of your report, I am looking at the first sentence of the third paragraph under the heading Evaluation Criteria and Requirements, can you tell me what that means?

A: As I understand it when you talk about structural activity you're talking about the actual molecule and how the structure of that molecule can effect the potential potency from a toxic reaction. The actual structure of that compound is what's being discussed.

Q: Can you put that in English for me or

simplify it?

A: I can try. The actual structure of the compound may have an affect on how that compound is absorbed, metabolized then based on that that may or may not have an impact on the toxic potency of the substance.

Q: Okay. And what this sentence is saying is that there is inadequate available information to determine?

A: From a structural activity standpoint. In terms of using that as the basis for developing acceptance criteria.

And I do think that if you go to the next two sentences that those are also important from the standpoint of making that paragraph clear in that we're not saying that you completely ignore structural activity.

Q: What are you saying?

A: I think it's very clear in the last two sentences and I would be happy to read those for you.

Q: Can you paraphrase if for me?

A: Basically that information that is available on a certain compound or set of compounds

relative to structural activity can be considered when you're looking at the amount of testing that's going to be necessary to validate the acceptability of that contaminant. To put it in laymen's terms structural activity is relative to the standard is not the end all be all of that decision making process, but it's part of the information that you consider.

Q: Who establishes MALs?

A: As previously indicated the establishment of MALs is one of our responsibilities as an organization relative to standard 61.

Q: So the answer to my question is NSF?

A: NSF sets MALs.

Q: Who establishes MCLs?

A: EPA, Office of Drinking Water.

Q: Is there a method by which MALs are coordinated with MCLs?

A: According to the standard the MALs are ten percent of the MCL, and the intent is for the MALs to be extremely conservative.

Q: So when you say that the NSF establishes MALs would it be more accurate to say that the MAL does the computation?

A: It depends on whether you're talking about regulated or unregulated contaminants.

Q: If it's an unregulated contaminant then the MAL is something that you folks do?

A: That we end up developing.

Q: Is THF regulated or unregulated?

A: That is unregulated.

Q: Cyclohexanone?

A: Unregulated.

Q: Methelethel keytone?

A: Unregulated.

Q: Is there anything in the composition of CPVC pipe that is regulated?

A: That's an extremely broad question and would be formulation dependent.

Q: So you can't answer it?

A: I think the question is too broad, if

[18] want to be more specific in terms [19] the particular [19] potential contaminant I will be happy to answer.

Q: Is there anything in CPVC that is regulated?

[22] A: Probably the best way that I can answer [23] that is to refer you back to the standard in terms [24] of the items that we would look for in CPVC,

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regulated metals –

Q: You said that you would have to look and [3] see what is in the CPVC is that because they're not [4] all created equal?

A: Actually I would not agree with that [6] statement that you made. I would say that the [7] standard does provide for extensive formulation [8] review of the materials that go into the finished [9] products regardless of whether they're PVC or any [10] other water contact material. And in that [11] formulation review the standard makes a provision [12] for the selection of additional contaminants of [13] interest based on formulation specific ingredients [14] in that material.

So you have a standard battery that would [16] be conducted based on our category of product [17] category, and then you have the ability to select [18] formulation dependent contaminants that you would [19] look for. That's the purpose of doing the [20] extensive formulation review.

Q: I think I understand. [22] I am looking at page six of your report [23] AWWA is what?

A: American Water Works Association.

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Q: And who are the members of the American [2] Water Works Association?

I am not sure specifically who that membership includes or excludes.

Q: Is it an industry group or is it a group [6] of municipal and governmental entities?

A: I do know that there is at least a [8] component of AWWA that is made up of manufacturers.

Q: What does the AWWA do?

A: They're involved in developing standards. [11] My experience with them has been from a standards [12] standpoint.

Q: Standards for what?

A: They develope performance standards for [15] various water products.

Q: Like CPVC pipe?

A: Typically not. I am not aware of any CPVC [18] standards. They tend to be involved with large [19] diameter piping systems that would be used in a [20] municipality, large city.

[21] Q: Okay. How about the ASSE?

[22] A: ASSE again an organization similar to [23] AWWA, they are a developer of standards, and their [24] standards typically involve mechanical plumbing

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[1] products of some type.

[2] Q: When you say mechanical –

[3] A: It could be a mixing valve.

[4] Q: And what does ASSE stand for?

[5] A: American Society of Sanitary Engineers.

[6] MR. GORDON: I think I am finished, I have no [7] further questions.

[8] EXAMINATION

[9] BY MS. CYZE:

[10] Q: In this last round of questioning here you [11] talked about things changing, I think it came up on [12] the context of the MALs that would seem to be [13] different then I think Mr. Gordon asked you a [14] question about the standards themselves changing [15] and you said no, it doesn't sound like that's the [16] same that you were saying at the end in terms of [17] evaluation –

[18] MR. GORDON: Is that a question or are you just [19] having a conversation.

[20] BY MS. CYZE:

[21] Q: So my question is was your answer [22] regarding the changes in the standards being due to [23] the acquisition of new information over time; is [24] that correct or incorrect, does it need changing?

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[1] A: It does need to be changed.

[2] Q: And what could be one of the reasons why [3] over the course of time the standards have been [4] changed in addition to I think what you testified [5] to the requirement that they don't –

[6] A: You have the five year minimum requirement [7] and then just like the MALs it's a dynamic world, [8] the standards are dynamic, whether they're the NSF [9] standards themselves or some of the standards that [10] are referenced in the NSF standards.

[11] Q: Okay. I also didn't understand your answer [12] to the question you were asked if you knew what [13] products leach out of CPVC and we have just gone [14] through a whole bunch of leaching issues and [15] originally you said no.

[16] A: I was thinking in context of formulation [17] dependent.

[18] Q: I don't know what you mean by that, when [19] you said no that you don't know what products leach [20] out of CPVC why did you say no?

[21] A: My interpretation of that question was [22] that it was looking for items that would be unique [23] to CPVC.

[24] Q: So what part of the process at NSF –

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[1] A: And I don't know of anything that is [2] unique to CPVC that extracts out.

[3] Q: So what part of the process at NSF is it [4] where you learn what the potential contaminants are [5] at issue?

[6] A: In our process one of our first steps is [7] the submittal of the product information which [8] identifies the raw material or materials that are [9] used and in that process our toxicologist reviewed [10] that information, they may or may not have to [11] request additional information from the ingredient [12] suppliers, and based on the sum total of that [13] information there's a determination made about what [14] I've referred to previously as formulation [15] dependent or contaminants.

[16] Q: So at some point you do know what products [17] are potential –

[18] A: Yes.

[19] Q: I think we have attempted to establish [20] that you're not a toxicologist and so there's been [21] a lot of questions on RVCM, THF, and the potential [22] health worker effects, leaching, and you've [23] indicated that you don't know, is there somebody at [24] NSF in developing the standards and in testing

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[1] products against those standards who does know that [2] information?

[3] A: Yes.

[4] Q: Okay. So it's not your job to be the [5] toxicologist at NSF?

[6] A: I employee be it indirectly because I [7] don't supervise them directly toxicologists.

[8] MS. CYZE: I don't have anymore questions.

[9] EXAMINATION

[10] BY MR. GORDON:

[11] Q: I just have a few, when you thought I [12] asked you whether you knew what leached out of CPVC [13] you said you thought I was looking for items that [14] may be unique to CPVC?

[15] A: Yes.

[16] Q: Okay. But then you went on to say that [17] your process is formulation dependent?

[18] A: There is a portion of the process that's [19] formulation dependent.

[20] Q: And that indicates to me is that

what [21] you're saying is you want to know what goes into [22] the product before we decide whether what comes out [23] of it may be harmful?

[24] A: That's incorrect.

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[1] Q: What did you mean?

[2] A: The purpose of the formulation review is [3] to determine based on the information on the [4] material and the ingredients that go into the [5] material to determine if they're specific analoids [6] that need to be tested that would not be part of [7] the standard battery of testing for that product [8] type.

[9] Q: So when you get a new product and you get [10] the formula you go through that formula to [11] determine whether or not there's anything that you [12] must test for that you wouldn't ordinarily test [13] for?

[14] A: Correct.

[15] Q: What do you usually test for?

[16] A: Again it's regulated metals, VOCs, RVCM, [17] and actually I think I left out tin in the past.

[18] Q: Anything else?

[19] A: I can actually look –

[20] Q: Tin?

[21] A: That's what I actually was going to look [22] at to see if tin was on there if you actually look [23] on page 5 of the standard tin and antimony are only [24] conducted during the formulation review, we

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[1] determined that they are stabilizers that are used [2] that contain tin and antimony.

[3] Q: Do THF, cyclohexanone, and methyl ethyl [4] keytone fall into any of those categories?

[5] A: The section that I was referring to was [6] for pipes.

[7] Q: Okay. When you test CPVC pipes do they [8] test it in a configuration that involves joining [9] pipes and fittings together with solvent cement?

[10] MS. CYZE: Objection, I am assuming we're [11] restarting since this is not anywhere close to the [12] follow-up questions that I had, so are you [13] continuing on with more deposition?

[14] MR. GORDON: No. This is a follow-up, we're [15] talking about leaching, when you test for [16] leaching.

[17] BY MR. GORDON:

[18] Q: When you test for leaching are you testing [19] for pipe or are you testing pipe which has been [20] joined with fittings with using a solvent cement?

[21] A: What are we testing?

[22] Q: When you're –

[23] A: Are you a pipe manufacturer or are you a [24] solvent cement manufacturer or are you a fitting

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[1] manufacturer.

[2] Q: When you test pipe do you test lengths of [3] pipe or do you test lengths of pipe that have been [4] joined together with fittings using solvent [5] cements?

[6] A: Let me restate the question to make sure [7] that I have got it. What you are asking me is when [8] we do chemical extraction testing on pipe from a [9] pipe manufacturer how do we do that, do we do that [10] as a piece of pipe or do we do that as an assembly.

[11] Q: Correct.

[12] A: Okay. The answer to that question would [13] be we do it as a piece of pipe.

[14] Q: Do you do chemical extraction tests on [15] solvent cements?

[16] A: Yes.

[17] MS. CYZE: Again I believe this is well beyond [18] anything that I touched on in my follow-up [19] questions.

[20] BY MR. GORDON:

[21] Q: And when you do chemical extraction tests [22] on solvent cements are the solvent cements in a [23] form where they've been used to join pieces of pipe [24] or in another form?

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[1] A: When we do chemical extractions on solvent [2] cements the samples used are joints made up of [3] pipe, fittings, and cements for that testing.

[4] Q: That's when you do chemical extraction [5] tests on solvent cements?

[6] A: Yes. It's done as an assembly.

[7] MR. GORDON: Thank you, that's all I have.

[8] MS. CYZE: We'll reserve.

[9] FURTHER DEPONENT SAITH NOT.

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STATE OF ILLINOIS)
) SS:
COUNTY OF COOK)

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS; EASTERN DIVISION

THE B.F. GOODRICH COMPANY,)
Plaintiff,)
vs.) No. 96 C 50346
LAKE IN THE HILLS, et al.,)
Defendants.)

This is to certify that I have read the transcript of my deposition taken in the above-entitled cause by NICOLE S. NERO, Certified Shorthand Reporter, on September 3, 1997, and that the foregoing transcript accurately states the questions asked and the answers given by me as they now appear.

RONALD COINER

SUBSCRIBED AND SWORN TO
before me this _____ day
of _____, 1998.
Notary Public

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STATE OF ILLINOIS)
) SS:
COUNTY OF COOK)

I, Nicole S. Nero, a notary public within and for the County of Cook County and State of Illinois, do hereby certify that heretofore, to-wit, on the 3rd day of September, 1997, personally appeared before me, at 100 South Wacker Drive, Chicago, Illinois, RONALD COINER, in a cause now pending and undetermined in the Circuit Court of Cook County, Illinois, wherein B.F. GOODRICH is the Plaintiff, and LAKE IN THE HILLS is the Defendant.

I further certify that the said witness was first duly sworn to testify the truth, the whole truth and nothing but the truth in the cause aforesaid; that the testimony then given by said witness was reported stenographically by me in the presence of the said witness, and afterwards reduced to typewriting by Computer-Aided Transcription, and the foregoing is a true and correct transcript of the testimony so given by said witness as aforesaid.

I further certify that the signature to the

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foregoing deposition was not waived by counsel for the respective parties.

I further certify that the taking of this deposition was pursuant to Notice, and that there were present at the deposition the attorneys hereinbefore mentioned.

I further certify that I am not counsel for nor in any way related to the parties to this suit, nor am I in any way interested in the outcome thereof.

IN TESTIMONY WHEREOF: I have hereunto set my hand and affixed my notarial seal this 20th day of April, 1998.

NOTARY PUBLIC, COOK COUNTY, ILLINOIS

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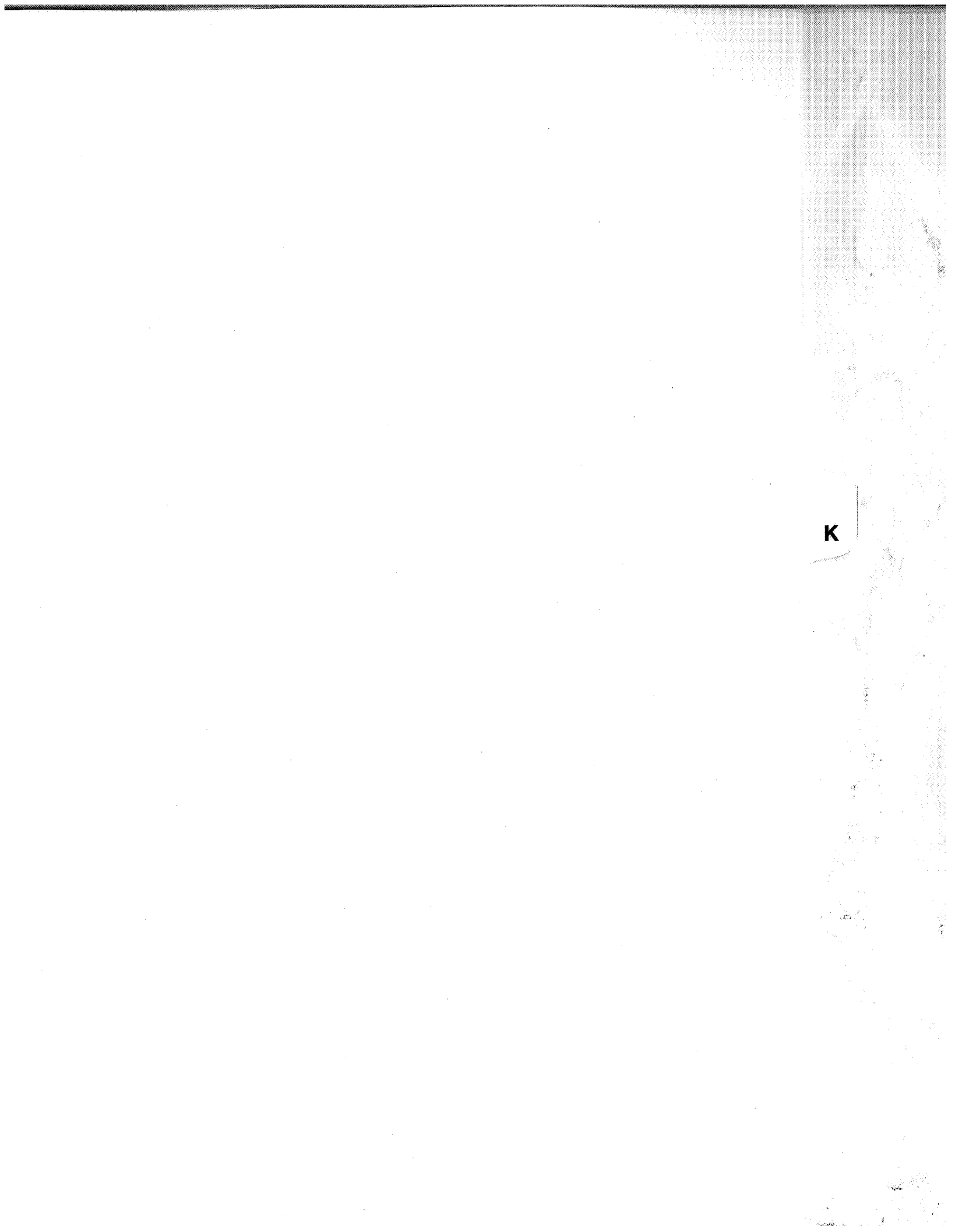
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Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT K

Ron Coiner Deposition, BF Goodrich vs. Village in the Lake in the Hills, March 24, 1998

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF ILLINOIS

WESTERN DIVISION

THE B.F. GOODRICH COMPANY,)
a New York corporation,)
Plaintiff,)
vs.) No. 96 C 50346
LAKE IN THE HILLS, ILLINOIS,)
a municipality of the State)
of Illinois; and DAVID SELLEK,)
Building Commissioner for Lake)
in the Hills,)
Defendants.)

COPY

The telephonic deposition of RONALD COINER called for examination pursuant to Notice and the Rules of Civil Procedure for the United States District Courts pertaining to the taking of depositions, taken before KYLA ELLIOTT, a notary public within and for the County of Cook, and State of Illinois, at 100 South Wacker Drive, Suite 1502, Chicago, Illinois, on the 24th day of March, 1998, at the hour of 1:00 o'clock p.m.

Reported by: Kyla Elliott, CSR, RPR
License No.: 084-004264

APPEARANCES:

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Representing the Defendants.

I N D E X

WITNESS	EXAMINATION
RONALD COINER	
By Mr. Gordon	5

E X H I B I T S

NUMBER	MARKED FOR ID
Coiner Deposition Exhibit	
No. 1	5
No. 2	82
No. 3	97
No. 4	98

MR. GORDON: Well, why don't we start with you stating your name.

THE WITNESS: My name is Ronald M. Coiner.

MR. GORDON: Are you the same Ronald M. Coiner who previously gave a deposition in the case entitled B.F. Goodrich versus Lake in the Hills?

THE WITNESS: Yes, sir.

MR. GORDON: We're going to swear you in, Mr. Coiner. Raise your right hand, please.

(Witness sworn.)

MR. GORDON: Are you alone in that room, Mr. Coiner?

THE WITNESS: Yes, I am.

MR. GORDON: If anybody else enters the room, would you let us know?

THE WITNESS: Yes, sir.

MR. GORDON: Mary Beth, is this the same Ronald Coiner who you know to be an expert witness in this case?

MS. CYZE: It certainly sounds like him.

MR. GORDON: Mr. Coiner, I'm going to start by providing the court reporter with a copy of a document entitled rebuttal expert report of Ronald Coiner, and I'm going to ask her to mark that as

Coiner Deposition Exhibit 1 with today's date. So bear with us for one minute.

(Whereupon, Coiner Deposition Exhibit No. 1 was marked for identification.)

RONALD COINER,

called as a witness herein, having been first duly sworn, was examined and testified as follows:

EXAMINATION

BY MR. GORDON:

Q. Mr. Coiner, I'm showing you what's been marked as Deposition Exhibit 1. Is that your expert report? Do you have a copy of your rebuttal expert report in front of you?

A. Yes, sir.

Q. We're referring to that as Exhibit 1.

Did you prepare this report?

A. Yes, sir.

Q. The entire report?

A. Yes, sir.

Q. I noticed that the format of this report was somewhat different from the expert report that you prepared previously.

Was this one typed in your location?

A. I actually typed this one myself, sir.

Q. And the previous one, who typed that one?

A. That was typed by someone in Mary Beth Cyze's office.

Q. And that's your signature on page -- it's an unnumbered page, but it would be page six?

A. Yes, sir.

Q. I'm going to be asking you a lot of questions about the report. But I'm going to put it aside for a second. Do you recall making -- participating in the making of a promotional videotape for B.F. Goodrich?

MS. CYZE: I'll just object as beyond the scope of the deposition.

MR. GORDON: Well, it certainly goes to motive, bias, and prejudice which is always relevant with respect to any witness.

MS. CYZE: The witness is not being directed to answer.

BY MR. GORDON:

Q. Mr. Coiner, you can answer my question.

A. So I am to answer the question?

Q. Unless somebody tells you not to, you are to answer the questions. There may be objections

voiced for the record, but that doesn't really relate to you.

A. Okay. Yes. I do recall making a video.

Q. When was that?

A. I don't remember the exact date. It was a number of years ago.

Q. How did you come to make that video?

A. NSF was requested to participate in that video.

Q. By B.F. Goodrich?

A. Yes.

Q. Did you receive any compensation?

A. No, sir.

Q. Where was that filmed?

A. It was actually filmed at NSF, at least the portion that I was in. The -- if my memory serves me correct, the video -- there's only a portion of the video that I'm in.

Q. That's correct.

Now, this is a video entitled an improved plumbing system; is that correct?

A. I don't recall the exact title.

Q. Did you see the video?

A. I saw it. It's been quite awhile.

Q. Do you recall saying in that video that B.F. Goodrich is concerned regarding the health and safety of persons using its product?

A. I don't specifically recall.

Q. Do you recall saying that you had worked with B.F. Goodrich for nine years and they were to be commended?

A. It's been a long time since I've seen the video.

Q. Is it fair to say you don't recall what you said?

A. I don't recall what I said.

Q. Okay. How was it determined what you would say?

A. There was a script provided by B.F. Goodrich, and that was reviewed with our marketing department. And as I recall -- and, again, I'd like to emphasize it's been a couple of years.

As I recall, there were changes that were requested by NSF in that script, and those changes were made. In fact, I'm positive there were changes that were requested in May in that script.

Q. And then you read from the script?

A. To the best of my recollection, yes.

Q. Do you remember what the changes were?

A. No, I do not.

Q. Have you ever made a promotional video for any other manufacturer?

A. I have participated in presentations before. But this is the first video that I have made. However, there are other people at NSF that have done similar things for other manufacturers and industry groups.

Q. It's the first video that you've made. And have you made any other videos for any other manufacturer?

A. I'm not sure I understand the question.

Q. Well, I asked -- you told me this was the first video that you made?

A. This is the only video that I personally have been involved with. But there are other people at NSF that have done similar activities.

Q. I'm not interested in them. I'm just interested in you.

A. All right.

Q. Thanks for the volunteered information, however.

I'd like to turn to your Opinion No. 1,

and I'm going to read it so that we have the language of your opinion in the record. And then I'll ask you some questions. Your Opinion No. 1 reads as follows colon -- hold on one second I'm going to get the court reporter a copy, too. So she can follow along.

Okay. Mr. Coiner, Opinion No. 1 in your rebuttal report reads as follows: "The NSF certification program for plastics plumbing products provides sufficient testing, both in the scope of items evaluated and the frequencies the evaluations are required in order to determine the acceptability of the products in the applications for which they have been certified."

Did you write that opinion?

We couldn't hear your answer.

A. Yes, sir.

Q. How did you know what opinions were being sought from you?

A. In terms of writing it, I typed it. I misunderstood the question. Rick Saines provided a list of topics, a list of issues. So an outgrowth of one of those.

Q. Was that in written form?

A. Yes, it was.

Q. Do you still have a copy of it?

A. No, I don't.

Q. What did you do with it?

A. I threw it away.

Q. And why did you do that?

A. I didn't see any reason to keep it.

Q. Do you remember what the document that -- when you say Rick Saines, that's Rick Saines from Gardner, Carton & Douglas?

A. Yes. I apologize, yes.

Q. Do you remember what the list said?

A. It had a number of topics for possible rebuttal.

Q. How many?

A. Three or four.

Q. Now, you have provided three opinions in your rebuttal report?

A. Yes.

Q. So that means that one of these topics you've discarded?

A. No, sir. Now that I think about it, it is correct. There were four, I believe that to be the case, and one of those was consolidated.

Q. Do you remember which one?

A. No, I don't.

Q. All right. After he gave you this list of subjects, what did you do?

A. He and I spoke on the phone.

Q. For how long?

A. Probably not more than an hour or an hour and a half.

Q. And then what happened?

A. Then I began to go to work on preparing the document that you see today.

Q. Okay. How did you prepare the document when you went to work on it?

A. Actually, I ended up taking information that I had as well as consulting with Lorie Bestervelt, our manager of toxicology services.

Q. You better spell her last name for the court reporter.

A. B-E-S-T-E-R-V-E-L-T. And she's listed as a technical resource in the rebuttal.

Q. Did she give you any documents?

A. She and I reviewed some correspondence between NSF and EPA. They were documents that I had seen before.

Q. You didn't list those documents as documents that -- under the heading of, data/other information considered, did you?

A. Basically, if you look at those it's the same opinions that are being addressed here in this report.

Q. No. I'm sorry. You didn't list those documents under the caption, data/other information considered by witness on page five of Exhibit 1, did you?

A. I did, actually. The data, Forsyth and Jay.

Q. You just told me that what you reviewed was correspondence between the NSF and the EPA. I don't see any correspondence.

A. That correspondence is about Forsyth and Jay and Sadiki.

MS. CYZE: So we can rewrite the extent he relied on those. We can certainly revise those and add those in.

BY MR. GORDON:

Q. I have a document in front of me which unfortunately you can't see. But it's a December 5, 1997, letter from Lorie Bestervelt to a document

clerk at the United States Environmental Protection Agency -- I'm sorry, a comment clerk?

A. Yes.

Q. Is that one of the things that you reviewed?

A. I'm familiar with that letter. I don't know whether that was something specifically that Lorie and I discussed on that occasion, but I am very familiar with that letter.

Q. Isn't it a fact that some of the paragraphs in your rebuttal report were taken almost verbatim from Ms. Bestervelt's letter of December 5, 1997?

A. Yes. And in fact, they should be very close if not identical.

Q. So this would certainly be a letter that you considered in formulating your rebuttal report; isn't that correct?

A. No, sir. I would not agree with the way you phrased that. What you see in the letter dated December 5th -- I believe that's the date that you've referenced. And what you see in the rebuttal expert report are opinions of NSF. And whether or not they appear in a letter to an

individual or they appear in this rebuttal report, that is the opinion of NSF, it's experts on these subjects.

Q. All right. Is what Ms. Bestervelt said and what you said in your rebuttal report just a prepared -- preprepared portion of the NSF position so that you could lift it from some other document and put it in your report?

MS. CYZE: I'll object to the characterization.

BY MR. GORDON:

Q. You may answer.

A. I would disagree. Again, what you're looking at is consistency.

Q. No. What I'm looking at, Mr. Coiner, and I don't want to be -- sound argumentative. But what I'm looking at is a letter written by someone else and a rebuttal report written by you. And they contain whole sentences that are taken out of a letter and put into your rebuttal report.

Is it your testimony that that's just a coincidence?

MS. CYZE: Objection.

THE WITNESS: That's not what I said previously. It's not a coincidence. What you see

is a consistent statement -- eight months used consistently by Lorie and myself on this issue.

I'm very happy to say again that prior to this expert report, I had seen this letter. I've reviewed this letter. What you're seeing in the expert report is simply, again, our opinion.

BY MR. GORDON:

Q. Is what I'm seeing in the report your opinion or somebody else's?

MS. CYZE: Objection, when you say, your opinion, I think Mr. Coiner's referring to our opinion being NSF. Is that also how you're referring to it?

BY MR. GORDON:

Q. Mr. Coiner, I want to make it clear to you that I don't really care about the opinion of a business entity such as NSF. NSF hasn't been designated as an expert.

As I understand it, you're the person who's been designated as an expert and you're providing your opinions not somebody else's.

A. And those opinions are consistent.

Q. Okay. Now, I'll ask the question again.

The opinions in your rebuttal report, are

those your opinions?

A. Yes.

Q. Now you had said you also looked at some correspondence, as you phrased it, between NSF and EPA. Did you see any correspondence authored by the EPA to NSF?

A. Not to my knowledge, no. I was referring to this December 5th letter.

Q. Is there anything else that you reviewed when you were meeting with Lorie Bestervelt?

A. The documents that are identified in the expert report were discussed.

Q. Anything else?

A. No, I think that's about it.

Q. How would you characterize the subject matter which precipitated Ms. Bestervelt's December 5, 1997, letter to the EPA?

A. I'm not sure I understand the question.

Q. All right. I'll ask a leading question then.

As of December of 1997, wasn't the Environmental Protection Agency accepting comments from others concerning its possible plan to investigate organotins in drinking water?

A. To my knowledge, they were working on a candidate list. They were not investigating.

Q. What do you mean by a candidate list?

A. If you're familiar with the Federal register, March 2nd --

Q. Well, I'm not.

A. -- they talk about the candidate list.

Q. I'm not familiar with the candidate list. Can you tell me what the candidate list is?

A. Sure. The candidate list is a list of contaminants. They're not addressed currently at EPA for drinking water. And it's a list that they're looking at specific activities associated with the compounds that are added to that list, and those include research, monitoring, guidance selection, and regulatory determination.

Q. All right. And one of the substances that the EPA was considering adding to its contaminants list was organotin; isn't that correct?

MS. CYZE: Objection, it's to the candidate list which is a big difference than characterizing it as a candidate list. It's the candidate is, I think, the accurate characterization. Without that preface on there, it's a mischaracterization.

BY MR. GORDON:

Q. Was the EPA considering adding organotins to its final contaminant candidate list?

A. Yes.

Q. Now, what is that a candidate list for?

A. It's a candidate list for determining further activities at EPA's drinking water program including water research, monitoring guidance development, selection of regulatory determinations. That's what it is.

Q. All right. And the purpose of Ms. Bestervelt's letter, was it not, was to object to the inclusion of organotins in the contaminant candidate list; isn't that correct?

MS. CYZE: I'll object to the characterization as objection, the Federal register that you cited, and I think you even referenced that it requested comments. And she submitted those comments to refer to them as objections. I think it's a mischaracterization.

BY MR. GORDON:

Q. You may answer.

A. We did not object. We provided comments.

Q. Well, isn't it a fact that

Ms. Bestervelt's comments could be summarized by saying that she saw no need to add organotins to that list?

A. That's correct.

Q. In fact, she wrote, did she not, "it is our opinion that the evaluation of PVC/CPVC pipe based upon the requirements of ANSI/NSF 61 is protective of human health and the presence of monoorganotin and diorganotin in potable water due to their use as heat stabilizers does not present a human health risk?

A. I don't have a copy of the letter in front of me. I don't know whether you're reading verbatim from the letter or not.

Q. Do you know what ultimate action the EPA took after it received comments such as those from Ms. Bestervelt?

A. Organotins are still on the candidate list.

Q. And what is the meaning of that?

A. I'm sorry?

Q. What is the meaning of being on the candidate's list?

A. Contaminants that's not otherwise

addressed by the drinking water program, and it's on the candidate list potentially. And I need to emphasize the word potentially or other activities including drinking water research, monitoring, guidance determination, and selection of regulatory determination.

Q. All right. Does that mean they're going to study organotins at the EPA?

A. No. It means that they could study organotins. It does not mean definitively that they are. That's based on my understanding of their process.

Q. Have you reviewed a Federal registered document published March 2 of 1998, with respect to the EPA's action concerning this candidate list?

A. Yes, I have.

Q. Did you read that portion of the -- you've read it?

A. I've had a chance to take a look at it since I came back. This actually came out and was received here after I left for a lengthy trip to the far east. So I haven't had a chance to study it in any great detail, but I have read it.

Q. Then you are aware that the EPA wrote that

it, quote, disagrees with the commenters who suggest that organotins should be deleted from the CCL?

A. It's my understanding that they've determined to keep it on the candidate list.

Q. Do you recall reading that the EPA determined that organotins quote are of sufficient concern to warrant further investigation period, end quote?

A. I'd have to go back and look at the document --

Q. Do you have a copy of it there?

A. -- and see what the wording is.

Q. Do you have a copy of it there?

A. Hang on a sec.

Q. If not, we can fax it to you.

A. Yes. I've got one. Okay. Where are you reading from?

Q. Under section J entitled organotins.

A. Okay.

Q. Do you see in the second full paragraph under capital J entitled organotins where the agency wrote that it believes that organotins, quote, are of sufficient concern to warrant further

investigation? Do you see that, sir?

A. I don't see the sentence you're talking about. No, sir. You're in the second full paragraph?

Q. Well, second full paragraph under capital J entitled organotins. Do you see that paragraph? It starts out with the words EPA disagrees?

A. I'm with you right there. Restate your question, please.

Q. Doesn't it say in part in the third sentence of the second paragraph that the agency believes that organotins, "are of sufficient concern to warrant further investigation?"

A. Yes, sir, it does.

Q. Now, do you also see the last sentence of that paragraph which reads as follows: "The agency requested this information from the NSF, and learned that due to confidentiality agreement, NSF cannot disclose this information, therefore we have not yet been able to assess the toxicological data."

Mr. Coiner, is it true that the EPA asked NSF for certain data regarding organotins and that the NSF refused to provide that information to the

EPA?

MS. CYZE: Objection -- Ron, you're going to have to let me finish.

I'll object to the characterization of this last sentence there. It doesn't say that EPA said it refused. It says NSF cannot disclose this information. It doesn't say that NSF refused to disclose it.

BY MR. GORDON:

Q. Did NSF refuse to disclose information to the Environmental Protection Agency?

A. No, sir. It is our intent to try to provide information.

Q. Has the EPA requested information from the NSF which NSF has not yet provided --

A. Excuse me, sir, I was not finished.

Q. Go ahead, finish your answer.

A. NSF has not refused to provide information. We have information that is confidential in nature. And in order for us to be able to provide that to EPA or to anyone, we have to get the permission of the people that own that data.

NSF does not own that data. It's not ours

to give out or distribute. And we are in the process of trying to get that authorization so that we can provide the requested information to EPA.

Q. Who is the owner of that data?

A. That, I do not know.

Q. Well, let me see then if I have it straight.

The agency, by that, I mean the EPA did request certain information from NSF; is that correct?

A. They requested information.

Q. And to date, that information has not been turned over; is that correct?

A. There has been information that has been exchanged.

Q. All right. Let me put it to you this way then, Mr. Coiner. And I've got all day and all night so we can beat around the bush.

MS. CYZE: Objection, Mr. Coiner is answering your questions.

BY MR. GORDON:

Q. Did the EPA request information that has not yet been provided?

A. There is information that has not been

provided because it is not NSF's to provide.

Q. Okay. The EPA requested from the NSF information that you folks have in your files and some of that information has not been turned over to the EPA because it's confidential; is that correct?

A. Because it is confidential information that, again, does not belong to NSF.

Q. Do you know the nature of that information?

A. No, I do not.

Q. Who would know?

A. Our toxicology staff.

Q. I'm going to return now to your Opinion No. 1. Is there a typo in Opinion No. 1, I guess that's my first question?

A. I can tell you right off the bat, I'm a lousy typist.

Q. We can all stipulate to that. What word is there that shouldn't be, or what word should be in there that we don't see?

A. Well, I can sit here and read the entire thing and try to find the words you're talking about.

Q. Why don't you just read the entire thing, it's only three lines and see if there's anything missing or anything incorrect in there?

A. And you're talking about in Opinion 1?

Q. Yes. If that's fine and there's nothing wrong with it, maybe it's just my way of reading it.

MS. CYZE: I'd write it differently, but I don't see a missing word.

BY MR. GORDON:

Q. No missing words, no additional words that shouldn't be there, Mr. Coiner?

A. Not anything that jumps out at me, no.

Q. How long has NSF been testing CPVC?

A. I don't know specifically how long we've been testing CPVC. I've been with the company I think now ten and a half years or so. It goes back, I know, prior to my employment at NSF.

We began working with the vinyl industry, primarily the PVC industry in 1957 with the development of our first standard in 1965. So there's quite a bit of history behind our activities.

Q. You've been with NSF for ten and a half

years you say?

A. Yeah. I've been with them since August of '87, whatever that works out to be.

Q. Pretty close. You said that you made that videotape several years ago. In the videotape you said that you had been working with B.F. Goodrich for nine years.

Would that indicate that this videotape was made about a year and a half ago?

A. I seem to think it's more like two years or maybe -- I'm kind of judging time here. I don't remember the exact date. I'm judging time because I've moved offices since then.

Q. Okay.

A. And I've been in this office I know at least two years, and I know I wasn't in this office when we did that.

Q. Do you know when NSF 61 was first published?

A. 1988.

Q. Do you know when the NSF started testing for regulated metals in CPVC pipe?

A. I don't know the specific date, but it predates standard 61 by a number of years. Prior

to standard 61, standard 14 for plastic plumbing products included its own health effects criteria and that included regulated metals.

Subsequent to the development of standard 61, those requirements in standard 14 were removed and replaced with a reference to standard 61 in order to ensure that there was consistency between the way plastics were evaluated and metal plumbing products were evaluated.

Q. What is a phenolic, P-H-E-N-O-L-I-C?

A. A class of chemical compounds that has a phenol group.

Q. Is this something that's tested when NSF tests CPVC pipe pursuant to standard 61?

A. Yes, sir.

Q. How long has NSF been testing for phenolics?

A. I believe, and I would have to go back and look at the old standard 14, that it, again -- the review for phenolics predates standard 61. I believe that is part of the old standard 14 test battery.

Q. What's a VOC?

A. A volital organic compound.

Q. Can you give me an example.

A. An example of a VOC. The alcohol that's used in hair spray.

Q. Is that something that is tested in CPVC pipe pursuant to standard 61?

A. In terms of volital organic compounds?

Q. Yes, sir.

A. They are tested for in CPVC.

Q. And how long has that been going on?

A. That does predate standard 61. So that was a class of compounds that were looked at under the old standard 14 health effects criteria, old standard 14 test battery.

Q. Did you also test for residual vinyl chloride monomer?

A. Yes, sir.

Q. How long have you been testing for that?

A. Prior to standard 61, again, it was part of the old standard 14 health effects criteria, health effects test battery.

Q. To your knowledge, has any testing ever lead to the rejection or recall of CPVC or PVC pipe product?

A. Could you repeat that.

Q. Yes. To your knowledge, has any NSF testing ever lead to the rejection or recall of a CPVC pipe or pipe product?

A. There have been products that have not met the acceptance criteria. Though there have been no recalls of products in the time period that I've been with NSF. Whether there were recalls prior to that for CPVC, I don't know.

Q. Were you with NSF when people became more concerned with the presence of residual vinyl chloride monomers?

A. I'm not sure I understand --

Q. I'll rephrase it.

A. -- became more concerned.

Q. Did there come a time that you know of when the NSF changed any of its testing criteria with respect to residual vinyl chloride monomers?

A. I'd have to go back and look. I don't know.

Q. You don't know whether it happened during your tenure at NSF or whether it ever happened at all?

A. Whether it happened during my tenure at NSF.

Q. But you do know that at some point in time NSF did change its testing criteria with respect to RVCM's?

A. What I do know --

Q. Yes, sir.

A. -- is that at some point in the past, and I don't know the date, NSF began to look at and understand standard 14 -- to look at residual vinyl chloride. And I find your question a little confusing. So I think that's what you're asking me.

Q. That's correct. Up until that time, whenever it was, they hadn't been looking at it and then they decided to start looking at CPVC pipe with respect to residual vinyl chloride monomers?

A. I don't know whether that predates CPVC pipe coming on the scene or not. It predates me.

Q. Do you know if once NSF started looking at RVCM's, was a determination made that certain pipe products should not be certified by NSF because of the presence of RVCM's?

A. I would have -- again, that period of time you're referring to predates me. So it was prior to me arriving in 1987.

Q. So the answer is you don't know?

A. The answer is, yes, that I don't know because it predates me. The time frame that you're talking about predates me.

Q. How does the NSF determine what tests are required for CPVC potable water products?

A. If you look in ANSI NSF standard 61, table 3.1 of the standards, it gives material, specific analytes. And these analytes are, as I've indicated in my expert report, regulated metals, phenolics, VOC's, residual vinyl choloride monomer.

Also products containing tin, stabilizers are reviewed for tin, products containing antimony, evaluated for antimony. And we also do a formulation specific reviewed or determined based on the ingredients. Are there any other potential compounds that we should extract for. That's done on every product, not specific to CPVC. That's just a matter of course of business.

Q. How do you know the ingredients?

A. Manufacturers provide us the formulation information.

Q. What do you do to check it?

A. We audit the production facilities,

reviewing their implant compounding. For instance, in the case of plastics they're actually adding the ingredients together at the production site.

We review ingredients, freight designations, manufacturer, the use level of those ingredients against the registered copy of the formulation that was submitted to NSF.

And by registered copies -- when NSF reviews a formula, that formula is then registered back to the plant as an original document that our auditors are provided with to conduct the review.

Q. So to determine what -- my original question I thought was, how does NSF determine which tests are required for CPVC potable water products? You gave me a list of what you do test, and I'm interested in finding out how you decide what tests are required.

A. Well, in my opinion, I gave you that information. In terms of -- I guess let me try it a different way.

In terms of ANSI NSF standard 61 table 3.1, that list of material, specific analytes the we referred to the regulated metals, the phenolics, the VOC's, and the residual vinyl chloride, those

have been determined based on our long history of evaluating vinyl piping products, both PVC and CPVC.

Based on the technology that's used to produce those materials, you know, things like, it's a vinyl. So you're going to have -- look for residual vinyl choloride. So there are some things that ultimately come down to being so simple that it's pretty easy to put them in a table and just say that these are going to apply to all vinyl compounds.

The formulation specific review that I talked about, again, that's based on the expertise of our toxicologist. Looking at the individual ingredients that are being specified by the manufacturer whether or not we have toxicological data on those ingredients, in some cases before we can make a decision where we don't have toxicological data in our files on those ingredients, we have to go back to the ingredients' supplier themselves and obtain that information.

Q. Okay. I'll --

A. Once you go through that process, then you're able to make a technical evaluation as to,

is there anything I need to add to the regulated metals, the phenolics, the VOC's, and the residual vinyl chloride in order to make sure that I'm going to be able to capture everything that's going into this final compound or this final product.

Q. Mr. Coiner, we seem to be like ships passing in the night here.

I'm not asking you how you decide what to test, what products to look for or what chemicals you look for. I'm asking you how you decide what tests to do?

A. We do them all.

Q. I'll try it a different way. I have a swimming pool in my backyard. I know that I have to have a certain level of chlorine in my swimming pool so that I don't get algae. I can go to the store, and there are four different tests that I can buy to determine the chlorine level.

How do you folks determine which tests to do in order to evaluate the product? I assume there are various ways you can look for tins for instance. How do you decide what method to use to look for tins?

Do you understand?

A. Yes, I think I understand. Thank you for clarifying that for me.

In determining what method to use, we look at the EPA methods and in some cases where there is not a method available, our chemists, our analytical chemists will develop a method. We have a methods development process that's used in those cases where there just simply isn't a test method.

Q. Now, when you are testing for a particular substance, does the NSF rely on formulation information that's submitted by a company that makes the product, or does the NSF do an independent test of the material to determine what constituents to test for?

A. The question that you've asked is a little exclusionary in that it has to be one way or the other.

Q. You can give me a third or a fourth or a fifth.

A. It simply isn't the case. It's not an exclusionary issue. As I've indicated previously, one of the steps in our process is to physically send the NSF's staff person to that production facility, be it here in the US or anywhere in the

world and validate that information that is being given to us from the manufacturer. We find that to be an invaluable step and a crucial step in this process.

Q. Does the NSF do any independent study of materials to determine what constituents to test for?

Did you answer?

A. I'm not sure I understand the question.

Q. I'll rephrase it. Let's suppose that you are testing CPVC potable water pipe and you have a particular pipe in your possession that you are going to test, does the NSF do anything to a piece of pipe to determine what constituents are in it?

A. That would -- I guess the reason I'm struggling with the question is I'm still thinking about how we administrate the certification program.

Again, when we get samples in the door, when we physically get samples in, those are samples that are collected by auditors. They're samples that we know the identity of. They're samples that we know what the constituent components were in that sample.

Though from the standpoint of doing some detailed chemical analysis to make sure that, you know, an apple is an apple and an orange is an orange, that would not be something we would typically do on a normal sample. And we wouldn't do that because we believe we've addressed that more than adequately up front of the standpoint.

Q. Are any CPVC pipes tested for antimony?

A. They would be if they contained an antimony stabilizer.

Q. Do some contain antimony stabilizers?

A. I guess it's possible. The products I'm familiar with contain tin-based stabilizers.

Q. Sitting there today, you don't know of any that contain antimony stabilizers?

A. We work with hundreds of formulations. So I know that there are CPVC products out there with tin-based stabilizers. In terms of antimony stabilizers, I would have to go back and do some further research.

Are we at a point we can take a break?

Q. Whenever you want.

A. I think I drank too much tea.

MR. GORDON: Let's take five minutes.

(A short break was taken.)

BY MR. GORDON:

Q. Mr. Coiner, are there any CPVC pipes that are not required to be tested for tins?

A. It would be dependent on whether or not they have a tin-based stabilizer or an antimony-based stabilizer. And in order to determine whether or not we have any products that are using an antimony-based stabilizer, I'd have to go back and consult files and have to do some research.

Q. In your opinion 1, you list things that the NSF tests for in CPVC products. And that you listed regulated metals, phenolics, VOCs, residual vinyl chloride monomers, and tin-based stabilizers and antimony-based stabilizers.

Are there any other things that the NSF checks for in CPVC pipe?

MS. CYZE: I'll object. You missed the sentence before that, that they also test for formulation-dependent analytes.

BY MR. GORDON:

Q. I'll rephrase the question.

Other than what you've listed in the first

paragraph of the basis portion of your Opinion No. 1, is there anything else that the NSF checks for in CPVC pipe?

A. And I assume that you're talking about from a chemical extraction standpoint; is that correct?

Q. Yes.

A. You look at the material, specific analytes coupled with the detailed formulation review looking at all the ingredients. That's the whole ball of wax. That covers it all. I don't know what more you could look for.

Q. In the basis portion of your Opinion No. 1, and I'm referring to the last sentence of the second paragraph. You say that there are 200 CPVC products produced by 37 companies that are certified to the requirements of standard 61.

Of those, how many are CPVC potable water pipe or fitting products?

A. Standard 61?

Q. No. Of 200 CPVC products that are for potable, how many are certified pursuant to standard 61 which are potable water products?

A. ANSI NSF standard 61, the standard that

addresses health effects, drinking water additives, components, health effects. So anything that is listed under standard 61 is a product that's intended for a drinking water application. If it were not intended for a drinking water application, it would not be certified against standard 61.

Q. Okay. Of the 37 companies, do all of those 37 companies make CPVC potable water pipes or fittings?

A. The last sentence in that paragraph talks about materials, pipe, fittings, and solvent cements. So those companies would represent all of those categories, materials, pipes, fittings, and solvent cements. It's more than just pipes and fittings.

Q. How many of the 37 make pipes and fittings?

A. I'd have to sit down and count.

Q. So you don't know?

A. It would be the majority, but I'd have to sit down and physically hand count to give you an exact number.

MS. CYZE: I believe Mr. Coiner gave you the listing book. If you want him to take a look at a

listing book and you have one in your office, we can count it up for you.

BY MR. GORDON:

Q. Mr. Coiner, all of those 37 companies that make potable water, pipe, and fittings --

MS. CYZE: Objection, that's not what he said. He said they either make materials, pipes, fittings, or solvent cements.

MR. GORDON: Objection, you didn't listen to the beginning of the question.

MS. CYZE: I apologize.

BY MR. GORDON:

Q. Of the 37 that make potable pipe and water fittings, how many of those are made from resins supplied by B.F. Goodrich?

MS. CYZE: I still think that it's incorrect the way you said it. He didn't say 37 make pipe and fittings.

BY MR. GORDON:

Q. Of the 37 that make -- whatever number of the 37 that make potable water pipe and fittings, how many are made from B.F. Goodrich supplied resins?

A. That's not a number that I would know.

Q. Are you aware of NSF testing any CPVC pipes or fittings that are not made with a B.F. Goodrich resin?

A. Absolutely. One of the things that I should probably point out to you is that NSF offers a certification for materials, the actual, in this case, for the sake of our discussion, CPVC materials.

Under that certification program, B.F Goodrich is certainly a listed company, but there are other companies that are listed for CPVC material. Off of the top of my head, without taking a look at the public listings, you have Georgia Gulf, another large US based CPVC material supplier that is NSF listed.

You also have, I believe their name is Elf Atochem. That is also a large CPVC material supplier in the pipe and fitting market making the same types of materials that B.F. Goodrich does.

So you have a number of material suppliers out there, one of which is B.F. Goodrich. In our certification program we're providing chemical analysis and performance evaluation of those materials and -- so it's not something that's

exclusive to B.F. Goodrich.

Q. I wasn't suggesting that it was. That's why I asked you what percentage you made from non B.F. Goodrich supplied resins. But you don't know that, right?

A. I don't know that. And I would expect, given the dynamic market that we're at and the fact that I would assume that you've got fierce competition in that market like you do in most US business, that number changes.

Q. The other two companies that you mentioned, do they make resins that are then utilized for CPVC potable water?

A. Oh yes, absolutely.

Q. Now, do you know whether B.F. Goodrich makes more than one type of CPVC resin?

MS. CYZE: I'll object to all of this line of questioning. Mr. Coiner's not providing any opinions as to the B.F.G. materials in this case other than the meeting of the NSF 14 and 61.

BY MR. GORDON:

Q. You can answer the question, Mr. Coiner.

A. Could you restate the question.

Q. Do you know if B.F. Goodrich makes more

than one type of CPVC resin?

A. They make a fittings grade and a pipe grade and several products within both of those categories. And that would be typical if you were to look at the other suppliers, Georgia Gulf and Elf Atochem as an example, I think you would find that both of those also make a range of materials for pipe and fitting applications.

Q. I can spell Georgia Pacific. But I bet that the court reporter doesn't know what to do with the name of that other company. So if you can spell it, it will probably help us.

A. You know I'm a bad typist. I'm a lousy speller.

MS. CYZE: E-L-F is one word A-T-O-C-H-E-M is the second word.

THE WITNESS: Did you get it?

MR. GORDON: Yes. Well, assuming that Mary Beth is a better speller than you are a typist, I guess we have it.

BY MR. GORDON:

Q. Do the different resins have different leaching characteristics?

MS. CYZE: I'll object. He's not here as a

toxicologist.

BY MR. GORDON:

Q. You can answer, if you know.

A. I'm not a toxicologist.

Q. I know that that was very helpful. But I don't know that toxicology was what I was searching for here. I'm just wondering if they have different leaching characteristics.

Do different things leach out of resins made by different manufacturers?

MS. CYZE: It's a different question.

THE WITNESS: I'm sorry. I couldn't hear.

BY MR. GORDON:

Q. Do different things, to your knowledge, leach out of the products made from the different resins?

A. Again, I'm not a toxicologist or a chemist. So without talking to technical experts in those fields, I wouldn't know.

Q. Okay. Fair enough. Mr. Coiner, I may have mentioned this to you previously. I did the other witnesses. This is not a test. This is not an SAT admissions test. If I don't know something, just tell me you don't know, and I'll move onto the

next question.

Is there any type of formal relationship between NSF and the United States Environmental Protection Agency that you know of?

A. Not to my knowledge, no. Could you define formal for me?

Q. Yes. Does the EPA, for instance, defer to the NSF to test products for it, or does the EPA rely on the NSF's testing of products?

A. They rely on NSF to develop the standard what is actually standard 61 developed at their request in 1985. So there is a reliance on NSF to perform those activities.

From the standpoint of testing and certification, I think you're getting into probably more of an issue of national or local building and plumbing codes as opposed to an EPA issue.

Q. All right. In any event, standard No. 61 was developed by the NSF at the request of the EPA?

A. Yes.

Q. All right. Has any part of the EPA's process of promulgating regulations been delegated to the NSF?

A. EPA is still the regulatory authority. So

we are not a regulatory -- NSF is not a regulatory body.

Q. Does the EPA on occasion ask the NSF to participate in the drafting of regulations?

A. You're now outside of my scope of expertise. Again, those context between NSF and EPA take place on a technical side with our toxicologists and chemists. So I'd have to defer, I don't know.

Now I've obviously -- we've already established that we actively participated in public comment. I would assume that you would find this consistently providing public comment.

Q. You said I'd have to check with the NSF chemists and what?

A. No, I didn't say you'd have to check with -- I said I would have to defer to them. Again, not being a toxicologist or a chemist, I'm not directly involved in the majority of those interactions with EPA staff.

Q. Okay.

A. But I think you can clearly see from Lorie Besterbelt's December 5th, letter 1997, that we clearly exercise our rights in making public

comment, different issues that come up at EPA.

Q. Is NSF standard 61 utilized as a standard by any other countries in the world?

A. Yes, it is.

Q. Which ones?

A. It's been determined to be equivalent with the Australian requirements for drinking water additives.

Q. I'm sorry. Australian?

A. Australian.

Q. What else?

A. It's been accepted as being equivalent in Columbia.

Q. Anything else?

A. There is a -- I don't have it with me, but there's actually a list of areas that have accepted products certified to NSF standard 61 as meeting their national requirements.

Q. Okay. Is there --

A. Those are two examples. There are others out there.

Q. Do you know if NSF at this point is marketing the use of NSF in any other countries?

A. We're certainly talking to other countries

about our process here, the process for the development of the standard as well as the technical content of the standard.

As an example, I recently returned from a trip in Japan where part of that trip was to make a presentation, a formal presentation about our process, procedures, and about the standards.

Q. Are you aware of any other countries other than Japan where this activity is going on?

A. Yes, I am.

Q. And what are those other countries?

A. I've provided those types of presentations in probably a half a dozen countries.

Q. Could you tell me what they are?

A. Taiyuan, Belgium, we've presented at an exhibition in Amsterdam last year.

Q. That would be the Netherlands?

A. Yes.

Q. Any others?

A. There are a number of others. I'd have to sit down and -- I've got a map at home with the pins and the countries that I've been in. I can go home and take a look at it.

Q. To your knowledge, based upon activities

in other countries, do you know whether other countries are allowing CPVC potable water systems which are not compliant with NSF 61 and the related ASTM standards?

MS. CYZE: I'll object as beyond the scope of his report. But the witness can answer.

BY MR. GORDON:

Q. You may answer.

A. My experience is that when you talk about national regulations, individual countries will look toward, in most cases, national regulations or the acceptance criteria for products that are manufactured and used in their countries.

What I typically find is that those manufacturers producing for the export market will typically go not to a national standard but to some standard that has some height and recognition internationally. And I think you find that both with the NSF standards, my experience, standard 14, and standard 61, that you'll find that those are heavily used in the export market.

And one thing I would add to that, they're typically used in the export market really for two reasons. One is recognition of the NSF

certification mart and the process it represents and the recognition of the standards as requirements, that in many cases particularly in the developing world.

Q. Mr. Coiner, with respect to the last sentence you just provided, is that based upon specific conversations you've had with people in other countries?

A. Yes.

Q. Who?

A. I couldn't sit here and give you names.

Q. I'm going to move on to your Opinion No. 2. Opinion No. 2 reads as follows: "CPVC piping products certified by NSF for potable water applications do not present a human health concern based on evaluation to the requirements of ANSI/NSF standard 61."

And then you have -- that is your Opinion No. 2; is that correct?

A. That is correct.

Q. And then you have approximately a two page long basis for that opinion?

A. Yes.

Q. All right. Were portions of the first

paragraph of your basis taken from Ms. Bestervelt's letter of December 5, 1997?

A. They should be consistent with her letter.

Q. Okay. So if the language tracked identically, that would be just a coincidence?

A. Again, I'm familiar with that letter. I'm familiar with that letter in December of 1997. If NSF is nothing, we are consistent.

Q. All right. I'm going to ask you the same question with respect to the paragraph that begins -- it's about four paragraphs down.

"Testing of CPVC piping products includes the initial qualification of the product followed by annual sampling."

Were portions of that paragraph taken from Ms. Bestervelt's letter of December 5, 1997?

A. The paragraph is pretty much a statement of fact, and I would imagine that if you ask anybody at NSF to provide that information, you're going to get, if not the identical statement, pretty darn close.

Q. That wasn't my question, sir. I wasn't asking about asking anybody else at NSF. I was asking you if you took portions of that paragraph

from Ms. Bestervelt's letter?

A. This would be my opinion. And if it's identical to the way Lorie wrote it, then obviously we're in agreement. I mean, I can't sit here and tell you that I sat down one afternoon and decided to pick apart her letter and pull pieces out. I'm certainly familiar with her letter, and obviously her opinions, in my opinion, were consistent.

Q. So you didn't do a cut and paste job with using her letter?

A. No, sir.

Q. You understand what I mean by a cut and paste job?

A. Well, even though I'm slowly learning Word Perfect, I assume you're talking about the cut and paste function.

Q. Well, actually I was just talking more about taking out a scissors and a roll of tape.

A. I try not to play with anything sharp.

Q. I think that within Word Perfect that it's copy and move.

A. I told you I wasn't very good.

Q. Can you describe for me the NSF test protocol for testing of four organotin compounds in

CPVC pipe?

MS. CYZE: Can you repeat that question.

THE WITNESS: You cut off.

BY MR. GORDON:

Q. Can you describe the NSF test protocol for testing for organotin compounds in CPVC potable water pipe?

A. Yes.

Q. Okay. Would you do --

A. There are two methods for doing the exposure. You can either do the exposure in product or in vessel. Specifically with a vinyl product, pipe or fitting, you're dealing with a homogeneous product meaning that the exterior is the same as the interior is the same as the midwall. So you only have one material in.

In those cases we will do an in vessel exposure which means essentially taking the samples of the product, putting them in a vessel, containing the extractant water. We then follow the procedures outlined in standard 61 where most products we are generating single time points which means you're following a protocol which has a 14 day conditioning with your data point being

generated on day 15.

In those cases where we need to do an overtime exposure, typically, you're looking at a 21 day protocol where day 15 is your first data point, and then you're collecting subsequent data points on the additional days.

That data is then -- or those samples that extractant water is then run through the chemistry lab. The results are generated, and those results are sent down to our toxicologist to be reviewed as outlined in standard 61 --

Q. Pursuant to standard 61, isn't it a fact that NSF doesn't actually measure organic forms of tin in CPVC potable water pipe?

A. It's measuring the inorganic form, then correcting for the molecular weight. And I actually think I say that in my opinion. And yes, I do. And it's in the second paragraph.

Q. I guess my question is, isn't it correct that NSF doesn't actually measure organic forms of tin?

A. That's correct. We're looking at inorganic tin and then correcting for the molecular weight difference.

Q. What type of tin is used in the manufacture of CPVC pipe where the tin is used as heat stabilizers, is it an inorganic tin or organic tin?

A. I don't know.

Q. Hold on a minute.

Do you know whether NSF has the capability to test for organic forms of tin in CPVC potable water products?

A. I don't know. I'd have to ask.

Q. Now, if you are testing for the presence of organotins using the inorganic tin test method that you just described, does that require the NSF to depend on the complete disclosure by vendors of the materials going into their products?

MS. CYZE: Objection, he's actually explained that whole process. That's already been asked and answered.

BY MR. GORDON:

Q. You can answer.

A. Could you restate the question.

MR. GORDON: I'm going to ask the court reporter to read it back, please.

(Whereupon, the record was read.)

THE WITNESS: I don't understand the question. I've already described how we handle the submittal of the information on the formula and the verification process through our field staff.

BY MR. GORDON:

Q. Well, you don't understand the question. So that's fine.

When you're doing the test for tin, do you know what the pH level of the water is?

A. I'd have to look it up in the standard to give you the pH.

Q. Okay.

A. I'd be happy to do that.

Q. If you've got the standard handy, that would help.

A. Give me a second to get it out here. It's pH 5 and 10 for metals.

Q. It's at 5 and 10; isn't that correct?

A. Yes.

Q. Are those the extremes of pH levels?

A. Yes. Those are considered to be the extremes when you look at it from the standpoint of metal extraction, again, not being a metallurgist, but based on my understanding of metals, there will

be certain metals that may have a tendency to extract out at a higher pH. You may have others that will extract out more readily at a lower pH. So it's intended to be an extremely aggressive test.

Q. Do you know which or what pH level is optimum for the extraction of organotins?

A. No, I do not.

Q. Has the NSF made a determination with respect to acceptable levels of tin present as a result of the testing -- let me rephrase that.

Has the NSF made a determination of acceptable levels of tin as determined through the standard 61 test?

A. We've determined acceptance criteria based on a review of data on organotins, specifically mono and dimethyltin and mono and dibutyltin.

Q. Okay. And what are those levels?

A. Those levels are in the expert report of the short-term exposure limit or the acute is 100 micrograms per liter for mono and dimethyltin and 100 milligrams per liter for mono and dibutyltin.

The maximum drinking water level, MDWL, chronic exposure is 30 micrograms per liter for

mono and diamethyltin and 20 micrograms per liter for mono and dibutyltin.

Q. Do you know how those levels were established for organotins?

A. Yes. In standard 61, if you take a look at appendix A, it provides a description of -- heading, acceptance criteria for unregulated contaminants.

Q. Okay. Other than what's set forth in standard 61 appendix A, do you know of any other method by which NSF set the action levels for organotins?

A. From the standpoint of standard 61 and the current work being done, that would be against appendix A. Now, obviously we've talked that standard 61 came into being at 1988.

Prior to that, again, it begins to predate me. So I'm not sure what the original procedures would have been.

Q. Are you aware of whether or not NSF has conducted its own toxicology studies regarding organotins?

A. I am not aware of any that NSF has conducted itself. And I assume you're talking

about things like reproductive toxicology, genotoxics, those type of studies. And that we're not talking about chemical extraction, looking at the amount of a particular contaminant in a product.

Q. That's correct. I'm asking you whether or not NSF has done any studies to determine the level at which any particular product may be considered toxic or detrimental to human health. And your answer is you're not aware of any such studies?

A. I'm not aware of any in the time that I have been here. Those studies are typically done by agencies like NTP which is the National Toxicology Program. Among other organizations that do that type of work, those type of studies are typically long-term. As an example, a reproductive toxicology study is a two year study. So these are very long-term, later generation activities.

Q. Does NSF rely on any vendor submitted studies?

A. We will accept studies that are generated from manufacturers, yes.

Q. Do you know whether NSF has accepted any studies on organotins from vendors?

A. I'm not sure where those -- not being familiar with the studies, I'm not sure where they came from. But, again, I got distressed that any time we received a study regardless of the source, that study is reviewed by our toxicologist and our technical staff to make sure that it is appropriate, that it provides all the information to ensure that the data was generated in a manner that's consistent with established good practices.

Q. All right. And so if you receive those studies, you review them internally?

A. They are reviewed initially internally. And then we have a health effects task group which is an external body that reviews the information associated with the acceptance criteria after we've done the initial work, digested the studies, come up with what would be proposed health effects --

Q. So the health effects task group is not made up of NSF personnel?

A. No. It's intended to be an oversight group. And it's made up of people representing organizations like US EPA, Health Canada, and other technical experts. It's intended to be a world-class group of toxicologists.

Q. All right. Are the reports prepared by the health effects task group considered by NSF to be confidential?

A. From the standpoint of the reports, there's not really a report that comes out per say. They're presented with the information, how we reached those conclusions with the studies, assuming that we have an agreement with the manufacturer to allow us to present those. And then they basically review the work and sign off on the work and it was -- that it was done properly and that we've reached a proper conclusion.

Q. Okay. The information that you provide to the health effects task group, is that considered confidential by NSF?

A. Some of it could be, yes. Because some of it may be the confidential studies developed by other organizations that have provided that data but have not released that data for general distribution.

Q. Is the NSF's protocol for determining acceptable levels of things such as organotins provide for certification of a product even if it has leaching levels that exceed the maximum

allowable level that NSF has determined?

A. Are you talking about the MDWL?

Q. Yes.

A. Maximum Drinking Water Level?

Q. That would be a good example.

A. We would not certify a product that's failed to meet the Maximum Drinking Water Level. It would be the acceptance criteria for health effects for a drinking water application.

Q. All right. I noticed in appendix A of NSF 61 -- do you have a copy of that handy?

A. Sure.

Q. It appeared to me that figures A2 and A3 contained a decision diagram which asks -- quote, is exposure greater than MAL justifiable, end quote?

MS. CYZE: Is there a question?

BY MR. GORDON:

Q. Are you familiar with that portion?

A. I'm sorry. What page are you on?

Q. I don't have it in front of me. But in appendix A there are figures A and 3 -- A2 and A3 which have decision diagrams which asks, quote, is exposure greater than MAL justifiable, end quote.

Do you see that?

A. Hang on a second.

MS. CYZE: And I'll just object to this line of questioning. This is what you should have asked in his first deposition, since that's all contained in his first report. But you're now --

MR. GORDON: I can't believe you can say that with a straight face. This whole document refers to NSF 61. I'm asking him a question about a diagram that NSF 61 --

MS. CYZE: Right. And that was all in his first report, and you could have gone over it then.

MR. GORDON: I didn't have to. I'm looking at opinion 2 which references NSF 61. And you're telling me I shouldn't be asking him a question about it? That's the silliest thing I've ever heard.

MS. CYZE: You're asking him -- if you take a look at his first report, that whole decision-making process was all in there. You can ask him about what's in report. But what you're referring to now, which you don't even have in front of you, is not in this report.

BY MR. GORDON:

Q. Do you see that decision-making diagram that I referred to?

A. I'm actually -- is it in appendix A?

Q. Yes. If you can't find it, I'll move on.

A. I'm probably looking right past it.

Q. Okay. In any event, would it be correct, Mr. Coiner, that you can't think of any considerations that would lead NSF to certify a product that exceeded the MAL?

A. I wasn't talking about the MAL.

Q. Okay.

A. I thought I made it very clear. I was talking about the MDWL.

Q. Well, let's talk about for MAL's then.

A. Okay.

Q. Are there circumstances under which your protocol allows you to exceed an MAL -- excuse me, I'll rephrase that.

Does the NSF protocol for determining MAL's provide for the certification of a product even if it has leached in levels exceeding the NSF MAL?

A. Again, and I want to stress, there is a

difference between an MDWL and an MAL.

Q. I know. I'm just talking about MAL's now.

A. And you've switched gears on me here. With the MAL's -- and I did find the chart by the way. With the MAL's in standard 61, figures A2 and A3 which are part of a larger flow diagram provide a process where you look at the MAL and as part of that process when you have an example where you see the exposure concentrations, okay?

Q. Yes.

A. It does provide a mechanism for the submittal of additional data which would, in effect, change the acceptance criteria. So it's not a question of, do you certify it if it exceeds the MDWL.

It's a question of when you do the original exposure, normalization of the data and you look at the data against, in this case, an MAL, are you going to need additional data, and is additional data available, either a reproductive study or a mutagenic study, some type of study based on the levels that you're finding, normalized levels, that you're going to have to have in order to justify that amount of the

contaminant.

And if those studies aren't available, then you would not be able to see that they are available, then you would have to sit down and go back through the process again of looking at setting appropriate acceptance criteria based on that additional information. The whole equation begins to shift.

Q. So if you receive one of these studies, then do you send it out to your health effects task group?

A. It would eventually go to the health effects task group after it's been reviewed, and the acceptance criteria has been established. That's the current procedure.

Q. What do you mean, the acceptance criteria?

A. Well, there's -- you know, from our perspective what we're doing is simply not taking -- here's the study. Here's this reproductive toxicology study and giving it to health effects task group.

We're sitting down and going through the process in appendix A to determine what the study means, what effect, if any, is going to have on the

acceptance criteria. And then taking that body of work, including the study, again, assuming that we've been given authorization to give the study to the health effects task group -- and I apologize, you're breaking my train of thought. And if we're under a time limit, let me know.

MS. CYZE: No, Ron, we're not.

BY MR. GORDON:

Q. Mr. Coiner --

A. Ask me a question, and I'm going to give you a full answer unless you tell me not to give a complete answer.

MS. CYZE: No. We're not under any time pressure.

THE WITNESS: So now somebody is going to have to read back to me where I was at.

MS. CYZE: Did you have a question?

MR. GORDON: Well, he wants his answer read back so he can add to it.

THE WITNESS: I was not finished.

(Whereupon, the record was read.)

THE WITNESS: And the function of the health effects task group is to take a look at that body of work and make a determination whether or not

that body of work is valid. It's a validation process. And the intent of that group is for us to have an oversight body so that we do have a check and a balance, if you will. It's very similar to our entire standards development process.

We bring together all the effected parties, manufacturers, product users, regulatory officials, on a balanced committee to work on writing of standards. And even in that process you have an oversight body. You have to counsel public health consultants.

MS. CYZE: I think he's answered the question.

BY MR. GORDON:

Q. I think he's answered his own question, but that's fine. Mr. Coiner --

A. Excuse me. Did I not answer your question?

Q. I think that you answered my question and then several others. But that's okay. I've got all the time in the world.

Does the information concerning levels of -- things such as tin, for instance, which you observed in the testing of the product influenced the establishment of MAL's?

MS. CYZE: Can you read that again.

THE WITNESS: I'm not sure that I understood the question.

MR. GORDON: Well, we're going to have it read back to you.

(Whereupon, the record was read.)

BY MR. GORDON:

Q. Do you understand the question?

A. No, they do not. They're basically -- you're establishing acceptance criteria and now you're talking about the amount of, in this case, tin that extracts out of a product. And that becomes part of your pass/fail decision, you normalize the data they have to tap levels.

Q. Did the NSF consider the action levels for organotins confidential?

A. No, they do not. They're part of my basis.

Q. No. At any time did the NSF consider the action levels for organotins confidential?

A. Again, they did. It was most likely part of my showing up on the scene.

Q. So to your knowledge, at no time since you joined NSF has NSF considered action levels for

organotins to be confidential?

A. I would actually phrase that, at no time since I took this position at NSF that I considered those to be confidential.

Q. I didn't ask whether you did. I asked whether NSF did. Is your answer the same?

A. I think so.

Q. To your knowledge, when Ms. Bestervelt wrote her December 5, 1997, letter to the US EPA, did the NSF disclose all of the information it had with respect to organotins?

A. Well, I think we covered this before. We provided them with information that was not considered confidential to the person or persons that owned that information. Any information that we were in a position to provide, we provided.

Q. And there's information that was not provided; is that correct?

A. Again, any information that was of confidential nature would not be provided until such time as we get authorization from that data to provide it. And we certainly would like to be in a position to provide that information. We think it will be very beneficial.

Q. But the bottom line is that there is information regarding organotins that was not submitted to the EPA; isn't that correct?

A. That's my understanding, yes.

Q. Are action levels for unregulated contaminants considered confidential by NSF?

A. They can be.

Q. And why is that?

A. Again, some of the information that may be used in developing those acceptance criteria can be of a confidential nature. And currently, we do not publish the acceptance criteria for the unregulated contaminants in standard 61. So that the end result is that they're typically handled staff internally here at NSF as confidential.

Q. Okay. You don't publish the action levels for unregulated contaminants, correct?

A. Not currently. It's not our intent to begin to do so but at this point we do not.

Q. And the reason for that?

A. At least from my perspective, I don't think there was much interest in the past. If you look at it historically, NSF at the very beginning, was the only organization that was providing

testing and certification services against the standard, and we were developing that acceptance criteria.

Now you have a number of other organizations that provide that same testing and certification program in standard 61. It becomes more important that we begin to put this criteria for unregulated contaminants in the body of the standard that you have consistency from certifier to certifier.

Q. Are there certain toxicology studies that have been used by NSF to determine action levels which are considered confidential by NSF --

MS. CYZE: Objection, asked and answered.

BY MR. GORDON:

Q. You may answer.

A. Yes.

Q. And why is that?

A. Again, we don't own the data that was used to generate those studies, and that data is considered confidential. It is a process that is similar to -- I'm sure a number of organizations that handle confidential business information.

Even I think the EPA and the way they

handle information under the Freedom of Information Act. If somebody provides them with confidential business information, they don't disclose that.

Q. Does the NSF certify thermal stabilizers that are used in CPVC resins or only the resins which incorporated the stabilizers?

A. We certify only the compound or the material which includes the resin and all the other constituent ingredients. We do have a program for stabilizers, but it's specific to PVC, not CPVC.

Q. Now, when the NSF receives information about thermal stabilizers, does that information come from the stabilizer manufacturers or from the resin manufacturers that use them?

A. Stabilizer manufacturer.

Q. If I used the word at-the-tap exposures or the phrase at-the-tap exposure, do you know what I mean?

A. Yes.

Q. Are at-the-tap exposure calculations based upon the normalized assumptions contained in NSF 61?

A. The normalization process described in standard 61 is intended to provide at the tap

normalized levels -- see at the tap.

Q. How are the at the tap calculated -- I'll rephrase that.

How does NSF derive the at-the-tap exposures?

A. Okay. How do we derive the at-the-tap exposures; is that correct?

Q. That's correct.

A. Are you talking about the chemical extraction procedure in terms of developing the extractant water and the chemical analysis, or are you talking about the gross calculation?

Q. The gross calculation.

A. Again, not being a toxicologist I don't do the calculation. That's their function, their responsibility. I can go to the standard, and we can look together if you have a copy of the standard at those calculations. They do vary depending on the type of product that you're talking about. For instance --

Q. Before you go answering something that I haven't asked --

A. Maybe I don't understand the question then.

Q. Do you know -- as I understand it, you're not a toxicologist. So beyond what's contained in the NSF 61, you don't know how those exposure are derived; is that correct?

A. Again, I think we have a terminology problem. When you say, exposure, are you talking about in the vessel, in the product exposures you're generating your samples, or are you talking about normalization factor?

In the standard when they use the word, exposure, they're talking about, again, as an example, in the vessel, making the product, putting it in the container with extractant water, going through that protocol.

Q. Okay.

A. I don't understand your question, I guess.

Q. Maybe I didn't ask it right because I don't understand it either. But I think you've answered basically what I wanted to know.

Does NSF use a multiplier to convert test results to predicted exposures?

A. There is a multiplier in the equation.

Q. Do you know the factor that's used for organotins?

A. It's not a -- if you're talking normalization factor, which I believe we're talking, it's not specific to the analyte. It's specific to the type of product we're talking about. Whether you're talking about a service line or a residential fitting or a water main product, your normalization factors are going to have a different multiplier.

Q. I'm talking about CPVC for in-home installation for use of potable water transmission?

A. Okay. I can get the standard out and give you the equation.

Q. No. You only use what's set forth in standard 61?

A. Yes. And appendix B.

Q. So is there a range of at-the-tap exposure levels found by NSF for mono-trimethyltin?

MS. CYZE: I'll object. He's already indicated he's not a toxicologist. To the extent he knows, he can answer.

BY MR. GORDON:

Q. I don't want you to give me any answers that you don't know. Just give me the answers that you know.

A. I don't know.

Q. You do not know?

A. I would, again --

Q. That's okay.

A. I'm not a toxicologist, and I don't typically review those data sets.

Q. Your answer would be the same if I were to ask the same question with respect to dimethyltin?

A. Again, I don't --

Q. You can just say yes -- that it would be the same. I'm just trying to save some time here.

A. It would be the same. I'm not a toxicologist, and I typically don't review those reports.

Q. Would your answer be the same for trimethyltin?

A. I'm sorry. Did somebody say something in the background?

Q. No.

Would your answer be the same for trimethyltin?

A. Trimethyltins, my answer would be different in that I do know that it's been our experience that tris have not been used as

stabilizers.

Q. So you don't have at-the-tap exposure levels for trimethyltin or tributyltin?

A. The tris, in our experience, are not used as heat stabilizers.

Q. So you don't have exposure levels for those, right?

A. They simply weren't used.

I'm going to need to take another break.

MR. GORDON: That's fine. You'll be happy to know that I'm half way through my page 9. And I only have one more page after that or you may not be happy. But let's take five.

(A short break was taken.)

BY MR. GORDON:

Q. Okay. I'm going to read Opinion No. 3 to you, Mr. Coiner, or I'm going to read it into the record. "The Forsyth and Jay (1997) organotin study does not present new issues concerning organotin leachate concentrations in water flowed through CPVC pipe."

And that's your opinion?

A. Yes.

Q. In formulating your opinion, did you have

an opportunity to review a letter written by Dr. Michael H. Fisch, F-I-S-C-H, to Mr. John -- he's with Witco, W-I-T-C-O -- to Mr. John Quackenbush, purchasing agent at B.F. Goodrich Company?

A. No, I didn't.

Q. All right. That letter was dated November 5 of 1997?

A. Neither one of those names rings a bell.

Q. Does Witco?

A. I'm familiar with Witco Incorporation, yes.

Q. What is Witco?

A. Manufacturer of stabilizers.

Q. I'm going to read a sentence written by Dr. Fisch, quote -- and this is in his letter.

MR. GORDON: Actually, I think I'll have the letter marked as exhibit 2.

(Whereupon, Coiner Deposition Exhibit No. 2 was marked for identification.)

BY MR. GORDON:

Q. Does Witco make a tin stabilizer?

A. Yes, they do.

Q. Do you know whether that stabilizer is used in B.F. Goodrich CPVC resins?

A. No, sir, I don't. That information would be in our confidential business information files, and I would have to go look at it specifically. But we as NSF, no, do I know right here, not here on the phone, the answer's no.

Q. Now Mister -- or excuse me, Dr. Fisch in the conclusion portion -- the first sentence of the conclusion portion of his letter wrote, "the work of Forsyth and Jay does not introduce anything new into the discussion of organotin stabilizers for pipe as it is well known that traced quantities will be presented in the water."

Now, I was looking at your Opinion No. 3 which says the Forsyth and Jay 1997 organotin study does not present new issues concerning organotin leachate concentrations in water flowed through CPVC pipe.

And it's your testimony that you never saw this Witco letter before you wrote your opinion?

A. That's correct. To my knowledge, I have not seen that correspondence.

Q. Has NSF ever found any triorganotins in

any CPVC products?

A. Not to my knowledge.

Q. Has NSF ever looked for any trialkytins in CPVC products?

A. Again, not being a toxicologist, no, it would be difficult for me to comment on whether or not we have done individual extractions looking for that in products based on the formulations. But, again, I can't emphasize that it's our experience that the tri family, tri species of ten is not used as heat stabilizers in this country.

Q. Do you know of any other study that has ever found trialkytins to have been leached out of a CPVC product?

A. Trialkytins?

Q. Trialkytins.

A. No, not to my knowledge. Unless -- no.

Q. All right. You mentioned that, to your knowledge, no manufacturer uses a trialkytin in a heat stabilizer, and that's why you don't have a protocol for looking for trialkytins?

MS. CYZE: Objection, I don't believe that he testified that they don't have a protocol for testing.

MR. GORDON: I'll rephrase it.

BY MR. GORDON:

Q. Mr. Coiner, did I understand you correctly that NSF does not look for trialkytin leachates from CPVC potable water pipe because no heat stabilizer manufacturer has indicated that trialkytins are utilized?

A. That's correct. If a manufacturer were to present us with a product that used a triorganotin, we would, of course, have to do that extraction.

But at this time it's our experience that triorganotins are usually used as biosides in industry and agriculture. And they just don't show up as heat stabilizers in CPVC.

Q. Okay. So --

A. What you see are the other species of ten.

Q. You're relying on the representations made by the manufacturers of the heat stabilizers in determining not to look for trialkytin leachates; is that correct?

MS. CYZE: Objection, he's answered that, and you're, again, mischaracterizing his testimony. He has gone through a full explanation at least twice now that they do not rely exclusively on what's

provided to them, that they have their own independent verification process. If you want to add that to part of your question, that's correct. But you're totally mischaracterizing what he has already stated clearly twice.

MR. GORDON: I'll rephrase it because I certainly don't want anybody to think I was mischaracterizing your testimony, Mr. Coiner.

BY MR. GORDON:

Q. In addition to your on-site examinations of manufacturing processes, the NSF has determined not to test for trialkytin leachates from CPVC pipe because no manufacturer of heat stabilizer has indicated that trialkytins are used in the creation of heat stabilizer tin; is that correct?

A. Again, I'm going to choose not to answer because I'm not a toxicologist, and I do not review the information that comes in from the ingredient suppliers like the heat stabilizer.

So I'm going to elect not to answer that question simply because I'm not familiar enough with the information that they're reviewing from the manufacturers, as I understand the context of your question.

Q. Has the NSF established action levels for trialkytin, tributyltin, trimethyltin?

A. No.

Q. Can you tell me what concentrations of organotins NSF has found in the CPVC products it has tested?

A. The only way I can provide that to you is to provide you some type of range or composite number generated by going through our records and looking at the individual tests.

Again, we're testing most likely hundreds of samples a year of CPVC product, and those individual data sets are considered confidential information. But I could provide some type of composited information based on those files.

MS. CYZE: It sounds like he didn't understand your question.

MR. GORDON: No. It sounds like he understood it.

BY MR. GORDON:

Q. Sitting here today, you don't know the range of the concentrations of organotins that you have found, you, meaning NSF has found in CPVC products; is that correct?

A. I don't know what the full range would be in terms of the smallest amount. It's exceedingly rare if ever that we would have an instance where we would exceed the acceptance criteria. But I don't know how low the bottom number goes, how little is found, what the smallest amount is, I don't know what that is.

Q. Do you know what the largest amount is?

A. Again, not without going back and looking at the files.

Q. Okay. Did you read the Forsyth and Jay study?

A. Yes, sir, I did.

Q. Do you know if NSF has ever found a higher level of organotin than did Forsyth and Jay when testing CPVC pipe before applying the NSF at-the-tap correction factor?

A. It's my understanding that the levels that were found in Forsyth and Jay were consistent with what we're finding. Now, in the basis I've indicated that the value equates to 17 -- that they found in Forsyth and Jay 17.5 per billion in water if you correct it for a 70 kilogram adult, it's well below the acceptance criteria.

Q. That wasn't my question though. Has the NSF ever found organotins at a greater level than did Forsyth and Jay before applying NSF's at-the-tap correction factor?

A. Again, I'd have to go back and look at the individual test results.

Q. Mr. Coiner, do you have any reason to believe that Forsyth and Jay were not studying potable water CPVC pipe that was certified by the NSF?

A. I don't know what they were studying in terms of the identity of the pipe?

Q. Yes, sir.

A. As I remember the study and I don't -- unfortunately, I don't have a copy in front of me but as I recall the study, they didn't identify with any great detail the product that they were doing the research on. So I don't know whether it was a product that was NSF certified or not.

Q. I'm going to take a minute to get my notes that indicate what they were testing so I can ask you a few questions about that. Bear with me, please. I'm going to --

A. Yes.

Q. One moment. I'm going to read some markings which Forsyth and Jay have stated were on the test sample, the pipe that they tested. And then maybe you can tell me whether or not that's something that would meet the NSF 61 standard, okay?

And you might want to -- if you have a piece of paper handy, it might be a good idea if you wrote this down as I do it because you'll probably want to look back at it.

A. Okay.

Q. Just one second. All right. I'm going to start out with something that looks like a bow tie followed by --

A. It must be Bow.

Q. Followed by the letters B-O-W, one half inch CPVC space SDR11 space tubing space 100PSI at 180 degrees F slash 82 degrees C space 4120PW space CSAB137 point 6.

A. Okay.

Q. Do you know if that pipe would meet the NSF 61 standard?

A. I can tell you that based on the markings that you've read, that that is not an NSF certified

product and whether or not it could or would meet any criteria, I would not know.

Q. Can you tell who this product is certified by?

A. In the print strip that you read, there doesn't appear to be any certification mark at all unless the CSA was actually the CSA mark as opposed to the letter CSA which can also go along with the B137 point 6, that's a CSA standard.

Q. Okay. Now, so B 137 point 6 is a standard?

A. It's a CSA standard, yes.

Q. What is CSA?

A. Canadian Standards Association.

Q. Okay. Do you know whether B137 point 6, that standard is equivalent to the NSF 61 standard?

A. That standard is, I believe, more of a performance based standard, more equivalent to the ASTM. The ASTM 2846 --

Q. Yes. So would that be equivalent to the NSF 14?

A. No. That would be more equivalent to the ASTM standard.

Q. Do you know whether this pipe is the

pipe -- do you know whether a pipe bearing the designation I read to you is approved for potable water in Canada?

A. No, I don't.

Q. Do you know whether NSF 61 references a Bow manufacturing facility in Canada that manufactures one and a half inch CPVC pipe?

A. Not off the top of my head but if necessary, we could look that up.

Q. Do you have a copy of the NSF listing?

A. Sure.

Q. Would you pull that out, and I'll get mine as well.

A. What date do you have on the book?

Q. I think this is the one you gave me when you were here. I don't have any date but --

MS. CYZE: May 7, 1997.

MR. GORDON: It says copyright 1997, NSF International. Yes, it's May 7, 1997.

THE WITNESS: What's the title of it?

BY MR. GORDON:

Q. NSF listings drinking water additives, health effects.

Should I be looking at the NSF 14 book

instead?

A. Bow has a listing under 14 and let me see under 16 if they have a separate one.

MS. CYZE: Stuart, remind me, was your question Bow in Canada or --

MR. GORDON: Yes.

MS. CYZE: Ron, did you understand the question to be Bow manufactured in Canada?

MR. GORDON: Yes, the plant. Bow has a plant that manufactures half inch potable water pipe.

THE WITNESS: Yes, I understand the question.

And based on the listings that I'm looking at, I do not see that product in the listing.

BY MR. GORDON:

Q. You don't see it in NSF standard 61 but you do find it in NSF 14?

A. No, sir. I don't find it in either which would be consistent with the fact that it does not have the NSF mark on it. So that it's not an NSF certified product based on the marking that you've read me. So that is not an NSF certified product.

Q. But the CSA does certify products for use in Canada?

A. They are a certification agency, yes.

Q. And do you know whether or not Bow manufactures CPVC pipe and fittings using a B.F. Goodrich resin?

A. No, I do not.

Q. Give me a minute to look through my notes. I might be about ready to call it a day here.

Mr. Coiner, earlier today we were talking about, for lack of a better word, action levels for tin, that was the level at which a product would be considered to have been leaching too much tin, do you remember that?

A. Uh-huh.

Q. Has the EPA ever approved of the action levels established by the NSF for tin?

A. The EPA typically does not approve or disapprove of an action level. Instead, they have acknowledged or recognized standard 61 as the vehicle by which you can make those determinations. So they've acknowledged the process by which you arrive at the decision.

Q. Was the EPA ever advised of the action levels for tin established by the NSF?

A. Again, in my position I have very little contact with the EPA. Based on our level of

activity with the EPA, I would be personally hard-pressed to believe that that information has not been shared.

Q. In your expert report, you reference under the portion of your report entitled data slash other information considered by witness, you reference the WHO -- excuse me, the World Health Organization 1980 report?

A. Yes.

Q. Do you remember the purpose of that report?

A. No. It was a stated purpose plus --

Q. Do you remember if that report was to establish an acceptable level for tributyltin?

A. I believe it did talk about tributyltin based on my recollection of information in that document.

Q. And do you remember --

A. My recollection though is that it talked about other types of tin other than the tri species.

Q. Do you remember that the report was generated because the World Health Organization was examining the danger to human beings from the use

of a product that was designed to kill off marine mollusks?

A. I'd have to go back and look at it. I mean, that sounds familiar, but I've read so much on the subject and others that I'd have to go back and look at the referenced document. I don't remember whether it was mollusks or what the -- no, I don't remember the specific detail that you're referring to.

Q. When was the last time you read the 1980 World Health Organization report that you considered?

A. Back in January.

Q. Of 1998?

A. That was something that I looked at in January of '98.

Q. Okay. And today is March 24th; is that correct?

A. Yes. And you're just asking me a level of detail that I don't recall from that document.

MR. GORDON: Fair enough. Thank you. I have no further questions, Mr. Coiner. Thanks for your afternoon. Wait, Mary Beth might have some.

MS. CYZE: No. Ron, I'm not in my office so

I'll talk to you tomorrow.

MR. GORDON: Wait, signature?

MS. CYZE: Reserved.

MR. GORDON: Thank you. Wait I do have one more thing. Just for the record, because we did -- I did talk about this document.

MS. CYZE: However, I know you talked about those letters, but you didn't have them in front of you. And he was not questioned with those as an exhibit or with those documents in front of him.

MR. GORDON: Actually, I did read a portion of Lorie Bestervelt's.

MS. CYZE: You read it and I wasn't given a copy of it nor did --

MR. GORDON: We're still on the record. I'm giving it to the court reporter so she can mark it as Exhibit 3.

Would you mark that as Deposition Exhibit 3.

(Whereupon, Coiner Deposition Exhibit No. 3 was marked for identification.)

MR. GORDON: And while we're marking things, I'm going to ask the court reporter to mark as

Exhibit 4 selected portions of a Federal registered document from the Environmental Protection Agency that was previously marked as Reed Deposition Exhibit 4.

(Whereupon, Coiner Deposition Exhibit No. 4 was marked for identification.)

BY MR. GORDON:

Q. Mr. Coiner.

A. Yeah.

Q. I have marked, as I just mentioned, some additional exhibits that I did refer to either in passing or in quotes during the course of your deposition. When the deposition is transcribed, you'll have an opportunity to review those documents.

And if those are not the documents that you thought we were talking about during the course of the deposition, I would appreciate it if you would tell me. Of course, you can tell me through the attorneys for B.F. Goodrich. Fair enough?

A. Okay.

MR. GORDON: Thanks very much.

MS. CYZE: Thanks Ron.

FURTHER DEPONENT SAITH NOT.

STATE OF ILLINOIS)
) SS:
COUNTY OF C O O K)

I, Kyla Elliott, a notary public within and for the County of Cook County and State of Illinois, do hereby certify that heretofore, to-wit, on the 24th day of March, 1998, personally appeared before me, at 100 South Wacker Drive, Suite 1502, Chicago, Illinois, RONALD COINER, in a cause now pending and undetermined in the Circuit Court of Cook County, Illinois, wherein B.F. GOODRICH is the Plaintiff, and LAKE IN THE HILLS is the Defendant.

I further certify that the said witness was first duly sworn to testify the truth, the whole truth and nothing but the truth in the cause aforesaid; that the testimony then given by said witness was reported stenographically by me in the presence of the said witness, and afterwards reduced to typewriting by Computer-Aided Transcription, and the foregoing is a true and correct transcript of the testimony so given by said witness as aforesaid.

I further certify that the signature to the foregoing deposition was reserved by counsel for

the respective parties.

I further certify that the taking of this deposition was pursuant to Notice, and that there were present at the deposition the attorneys hereinbefore mentioned.

I further certify that I am not counsel for nor in any way related to the parties to this suit, nor am I in any way interested in the outcome thereof.

IN TESTIMONY WHEREOF: I have hereunto set my hand and affixed my notarial seal this _____day of _____, 1998.

_____
NOTARY PUBLIC, COOK COUNTY, ILLINOIS

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT L

NSF International, NSF Tetrahydrofuran Task Group, "Minutes for the July 10, 1997 Task Group Meeting" July 25, 1997

NSF International
Ann Arbor, MI • Sacramento, CA • Washington, D.C. • Brussels, Belgium

MEMORANDUM

TO: NSF Tetrahydrofuran Task Group

FROM: Jane Wilson, Project Manager - Standards

DATE: July 25, 1997

SUBJECT: Minutes for the July 10, 1997 Task Group Meeting

Enclosed please find the draft minutes for the July 10, 1997 meeting of the NSF Task Group. Please review the minutes and forward any comments or corrections to my attention at your earliest convenience.

The NSF staff thanks you sincerely for your participation in working toward a consensus recommendation and looks forward to our continuing interaction on the tetrahydrofuran issue.

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NSF TETRAHYDROFURAN TASK GROUP

DRAFT MEETING MINUTES
JULY 10, 1997

Welcome, Self-introductions, and Antitrust Statement

Andrea Jensen (NSF - Senior Director, Standards) brought the meeting to order and asked the task group members for self introductions. Dr. Dennis Mangino (NSF - President) welcomed the group and stated that this meeting is one of several efforts taking place at NSF to refine the MAL setting process. Dennis described the other changes taking place at NSF. He mentioned the restructuring of the NSF Toxicology Department. Dr. David McFadden was introduced as the Director of Risk Assessment, with the technical focus of MAL development. He introduced Dr. Lori Bestervelt (NSF - Manager of Toxicology Services), and described how she is working closely with the Standards and the Certification Programs to integrate the information from the MAL development process. The MAL process is being redesigned so that there is input from all of the stakeholders involved when "high impact" MALs are being developed. NSF is also planning to publish its MALs in order to ensure that certification is more uniform and consistent between certifiers.

Ron Coiner (NSF - General Manager, Plumbing and Related Programs) also welcomed the group. He emphasized that NSF has made no decision regarding any change to the current criteria for THF, and it is not known when or if any change will occur. The Certification Program is not prepared to implement any change in the criteria. It is the intent of the Certification Program to make a decision only after the industry and regulatory communities have reached a consensus recommendation. If NSF makes a change for THF or any other high impact MAL, ample opportunity for reformulation and requalification of affected products will be made.

Andrea read the NSF Anti-Trust statement and offered the policy to anyone interested in reviewing it.

Review of Task Group's Goals and the Consensus Process

Andrea stated that the goal of this task group is to consider all relevant information for the purpose of making recommendations to the NSF Health Effects Task Group (HETG) regarding the THF MAL. She reviewed the agenda for the day and asked for any additional agenda items from the group. Ed Ohanian (EPA Office of Water) asked about the specific role of the Health Effects Task Group in relation to the group meeting today. Andrea replied that the high impact MALs will now be established in a more formal way, including a peer review by the HETG . She added that NSF is in the process of selecting membership for the HETG, and developing an agenda.

Summary of Standard 61 Solvent Cement Test Protocol and Exposure Data

Peter Greiner (NSF - Assistant General Manager, Drinking Water Additives Program) gave a review of the Standard 61 solvent cement test protocol. He described the sample preparation procedure and the extrapolation of laboratory data to short term and long term exposure values. The Standard's assumptions for residential applications are 280 feet of pipe (hot and cold lines), containing 100 fittings (200 joints), or one joint every 1.4 feet of pipe. The solvent cement is exposed using an in-product exposure assembly. Pete briefly reviewed the history of the development of the assembled exposure rig, and compared it to the previously-used overlapping slide technique. He reviewed the procedure for assembling the exposure rigs,

and the conditioning and exposure protocols for various situations. The in-product exposure of the cement minimizes normalization in that the product is already being exposed under conditions approximating field use. Correction is done for the duration of the exposure as needed. Pete provided an example of typical extraction results and how the extrapolation of overtime exposure data is performed. The reason for the overtime analysis is to predict what the long term exposure to the contaminant will be. The group discussed the extrapolation process, and how accurately it might reflect what is happening in the field. Chuck Bush (Oatey) asked how long the assemblies are allowed to cure and whether or not they are weighed before and after the cement application to monitor consistency of the amount applied. The group discussed the sources of variability in the procedure. The group discussed whether data was available to assess the actual long-term field exposure. Pete recalled that NSF was unable to locate such data in the past. Andy Olah (BF Goodrich) suggested that PPFA could look into generating a well-controlled study to assess this issue. The group had further discussion about the kinetics of the THF extraction into water, and how it might change if the curing time were extended. Pete suggested that the data he has reviewed indicates the THF is released to water at about the same rate as it is released to air. Ralph Parod (BASF) thought the calculated exposure is probably very conservative by a couple orders of magnitude. John Biesemeier (Great Lakes Chemical) asked about the term "normalized" exposure. Pete explained that normalization is the process of converting the laboratory condition to what the consumer is exposed at the tap. John asked if we have ever looked at mass balance. Pete said to his knowledge it was only performed once.

Pete emphasized that it is NSF's desire to simulate as closely as possible the real world exposure, but this protocol has been designed to evaluate many types of joining and sealing products, and is not specific to solvent cements. Andy Olah again suggested PPFA's involvement in assessing the real world values. Andrea agreed that if the information could be obtained in a controlled fashion, then it would be useful in making this assessment. She suggested that the best way to do this would be to form a task group to standardize the test procedure, and to make sure that the data can be applied to the standard. The standard should be written so that products are not failed because the standard does not accurately assess real world values. Carrol Voss (Arrow Adhesives) suggested that another variable to consider is the actual water intake of the average person.

Tom Heldridge (William H. Harvey Co.) asked what are the current levels of THF exposure being accepted. Pete indicated that the products presented in his overhead were accepted, and David McFadden (NSF - Director of Risk Assessment) reviewed the current THF criteria (non-confidential) for the group. The STEL is 32 ppm, and the current MAL is 50 ppb. Pete explained how these values are applied to the normalized data.

Conclusions of the NTP Inhalation Studies

Dr. Sree Jasti (BASF) gave an brief overview of the NTP study, since it had been reviewed in detail at the May meeting. The overall conclusions of the NTP two year bioassay were limited evidence of male rat kidney tumors and sufficient evidence of female mouse liver tumors after lifetime exposure to THF. Sree added that after reviewing the initial findings, the THF manufacturers thought about development of a research program to further look into the risk assessment issues which were raised by the NTP conclusions. An initial program to look into the metabolism and mechanism of toxicity of THF has been designed, since this data is not currently available. This is the initial phase of the data generation, and will include studies with tissues that are available from the NTP study if possible. Sree added that the plan includes determination of whether any protein casts were in the male rat kidneys, because the α-2-microglobulin mechanism could explain the tumor findings in the 600 and 1800 ppm male rat dose groups. It is planned to see if a NOEL can be demonstrated for these endpoints.

Once mechanisms have been identified, the program will look into other issues such as metabolite formation, repair mechanisms, and tissue dose response. Sree added that it appears inappropriate to use a linear low

dose extrapolation approach, since it does not appear to be a genotoxic mechanism. Sree stressed the need to understand if humans are like the mouse or the rat, or neither. Once more is known about metabolites of THF, such as whether the ring opens, a better opinion on carcinogenic potential can be formed. Sree also noted in the NTP study that the tumor incidence for the female mouse liver was within the historical control values for the 200 ppm and 600 ppm dose groups. The tumor data is only marginally significant for the low and mid dose groups. The higher classification of "clear evidence" appears to be based on the development of the two carcinomas at the high dose level (1800 ppm). Sree stressed the need to understand if there is a threshold instead of assuming a linear approach.

Review of Appendix A Requirements

Jane Wilson (Project Manager - Standards) reviewed the major decision points of the Standard 61, Appendix A evaluation criteria. The first decision point is a determination of whether the contaminant is regulated or unregulated, and the standard provides flexibility to use EPA Maximum Contaminant Levels (MCLs), or other regulatory values such as the Canadian MACs. The Maximum Allowable Level, or MAL, is then calculated directly from the regulated value by applying the 10th multiple source factor to the MCL or other regulated value. When evaluating an unregulated contaminant, the level of toxicity data required (Level I through IV) is driven by the normalized exposure to the contaminant. The toxicity data requirements are cumulative, so for a Level III exposure, Level I and II data requirements also need to be satisfied.

The second decision point is how to calculate the Maximum Drinking Water Level (MDWL) for an unregulated contaminant. This decision is driven by whether an unregulated contaminant is determined to be a carcinogen or non-carcinogen. The standard's criteria for a carcinogen is whether or not a contaminant meets the U.S. EPA classification of either an A, B_1, or B_2 carcinogen. In order to derive the Maximum Drinking Water Level (MDWL) for a non-carcinogen contaminant, the appropriate NOAEL is selected, and safety factors and dose conversions are applied. For a carcinogenic contaminant, the MDWL is calculated from a slope factor obtained using the Linearized Multistage model (LMS), or other appropriate model when justified, and the desired level of acceptable risk. Kavsy Dastur (E.I. DuPont) noted that the studies proposed for the research program on THF are not listed in the Level I - IV requirements. Jane explained that the standard allows use of supplemental data, such as mechanistic or pharmacokinetic studies, that help clarify some toxicity issues that are not clear cut.

Jane also reviewed calculation of the short-term exposure level (STEL), which is intended to be protective of acute effects for chemicals which initially extract at high levels and subsequently decay to lower levels. The STEL is calculated from either a 90 day subchronic study (preferred) or a 14 day acute study. Acute effects are considered to be any endpoint but cancer. Martin Ocedek (Wiltic) stated that at the May 20 meeting, the group was told that Standard 61 has an established protocol, and that revisions to the standard would be required prior to allowing the use of the data the industry planned to generate. Jane explained that the standard already contains the flexibility that would allow the use of the data without any revisions, but that NSF recognizes the need to update the requirements to reflect more current risk assessment practices. Andrea added that recent revisions had been made to the standard to emphasize the flexibility that has always been included, and that the use of other risk assessment models would not be constrained by the Standard in its present form.

Review of Criteria for Evaluation of Studies

Lori Bestervelt presented a review of the criteria for evaluation of studies in the development of NSF MALs. Before a study is used, a determination of the validity of the data is required. The standard references several sets of guidelines which can be consulted for this determination - EPA, OECD, FDA, etc. Acceptable studies must also be performed to Good Laboratory Practice (GLP) requirements. Lori reviewed some of the

parameters used to help assess the suitability of the data - the title and study objective, information on the test compound (purity, etc.), appropriate animal model, dose selection, route/duration of exposure, types and frequencies of tests, analytical measurements, description and use of appropriate statistical methods. In assessing the suitability of the data, the NSF reviewer will determine the study's adherence to the stated protocol and the appropriateness of the design to meet the objective(s) of the study. The relevance of the study's information to the development of the NSF MAL is also assessed. Lori briefly explained the use of study summary sheets that aid in the assessment of the study information. Recognizing that the guidelines for study acceptability have changed over time, Tim McCarthy (ARCO) asked if a study would still be considered usable as long as it was performed to the guidelines in effect at the time the study was performed. Lori stated that NSF would consider it acceptable if it met the guidelines in effect at the time of the study. Ed Ohanian added that he was a member of a task group which reviewed that NSF MAL process in the recent past, and that the task group had found the NSF process to be quite thorough in its review of data. Ed added that the addition of peer review would further enhance the credibility of the process.

Open Discussion on the Draft MAL Assessment

Jane asked for questions and discussion of the draft THF MAL document that was in the meeting package. Bob Hinderer asked what is NSF's position as to carcinogen classification of THF. Jane responded that is an important issue that the group is here to discuss. It is an issue on which NSF wants to hear the Task Group's input. Bob suggested that NSF also review other carcinogen classification systems to compare the THF data set to other chemicals which have already been classified. Bob presented some overheads on the ACGIH carcinogen classifications, and some chemicals which had been evaluated under the ACGIH scheme. Bob's observation is that THF would be an A3 or A4 chemical under the ACGIH system, given how some other chemicals had been classified (A3 - Animal carcinogen, A4 - Not classifiable as a human carcinogen). THF has negative mutagenicity data, renal tumors in male rats, hepatocellular adenomas and carcinomas in female mice, and no epidemiology data. While two sites of tumor development are possible, the sex/species specific aspect of the renal tubular carcinoma needs to be evaluated. The hepatocellular tumors could be a high dose phenomena. While Standard 61 does not reference the ACGIH classification scheme, NSF could use it as a basis for technical comparison. Kavsy Dastur asked if A, B_1, and B_2 carcinogens are treated the same way under Standard 61, and Jane confirmed that they are.

Ed Ohanian cautioned against making conclusions based on the summaries of the ACGIH classifications presented without examining the detailed evaluations. Bob agreed, and said his goal was to get an idea of what NSF is thinking on this issue, and to see if other classification systems can provide a check on the usage of subjective data. Ed concurred with the approach as long as the evaluation of the data is clear and transparent. Ed added that the NSF assessment is a good start, but that it needs to go further. The dose response must be taken into account. Ed also suggested that the strengths and limitations of the NTP study be discussed in the document, and that the assessment should extend to a characterization of the risk. Ed noted that NSF is trying to be consistent with the criteria developed by the health effects task group, but agreed that the criteria are overdue for updating. Bob said that the industry has been happy with the NSF risk assessments up to this time, and is encouraged that NSF is seeking outside input on one of such importance.

Neil Krivanek noted that the risk assessment value is assumed to be constant over the 70 years of human lifetime exposure, and it is not adjusted for the decrease in extraction over time. The amount of THF to which one is exposed on Day 90 is significantly different than at Year 65, and suggested that this be considered in the calculations. The group also requested copies of the Becker et al. study (study was located and copies provided to the group at the meeting). Neil also questioned the conclusions drawn in the Appendix III comparison of the intraperitoneal (IP) LD_{50} to the inhalation LC_{50} in rats. He suggested that if the IP administration was expanded out to the 3 hour dosing time used in the inhalation study, the body dosages would have probably been similar. Neil asked what the next step for the document is now that a draft has been proposed. Lori said that NSF will work to make it more detailed, and to incorporate comments provided

by the task group. Ed said that he views the current draft as a summary of the data, but that it needs to go further. Risk characterization discussion is missing and needs to be developed. Andrea said that a key issue is a discussion of additional data needed, and possibly NSF needs a small task group to study this. Tim McCarthy raised a question about the safety factors used for the STEL calculation. An additional 10x safety factor was used in the draft NSF assessment due to the subchronic NOAEL's proximity to the possible rat kidney tumor endpoint. Tim didn't think this factor was necessary due to the fact that the endpoint was seen at the 200 ppm dose only, and wasn't seen at higher doses. Lori agreed that it represented a very conservative approach, and NSF recognizes it as a point of discussion. Neil Krivanek added that the default use of 10x safety factors is outdated and that some thought should be given to selection of appropriate values. Tim agreed, and suggested that the mechanistic studies may provide information that would help in the rationale for selecting an appropriate number.

Discussion of Additional THF Data

Jane presented the additional types of data that NSF is trying to assemble. The NTP study mentions the possible relationships between other cyclic ethers such as furan and 1,4-dioxane, and their relationship to THF. This data is being researched by NSF, but no conclusions have been reached to date. NSF has also tried to locate any relevant occupational or epidemiological data. NSF has located some data on case histories of approximately six workers exposed occupationally to THF (see attachment). These studies are being reviewed for any relevant information. Since the subjects were exposed via inhalation, the significance to oral exposure in drinking water is not clear, but the articles may provide some information on human toxicity of THF. Kavsy Dastur asked if data on the occupational levels to which workers may be exposed would be useful. Jane explained that without some link to health effects monitoring the data probably would not be of use in the MAL development. Jane stated that if the industry had any data it is willing to share in either of these two areas, NSF would be willing to review it.

Discussion of Key Assumptions Used in the NSF Risk Assessment

Jane reviewed for the group the most important areas where assumptions have been made in the draft MAL report. The biggest question is whether NSF has sufficient evidence to proceed with the assumption that THF is a carcinogen under Standard 61 criteria. The current EPA guidelines give general criteria for "sufficiency" - multiple tumorigenic observations have been made in one or more experiments, or a single study in which an unusual response was observed. Martin Ocedek asked what is NSF's current position on this question. Lori responded that NSF is trying to determine this and wants input on this issue. Ed Ohanian said that he cannot give an opinion on THF's evaluation under the proposed EPA classification system. He added that it would be premature to make a conclusion at this point since the NTP study is just one piece of the data set, and other important pieces are missing. EPA has not spent any time reviewing this study. After this meeting Ed plans to review some aspects of the NTP study in more detail, as he has some issues such as mortality that need to be considered. The group discussed the possibility of any other data being generated, including internationally. Jane said that NSF is not aware of anyone doing an oral study, and that NSF's office in Brussels could look into whether any studies are being performed in Europe. Sree said that BASF is not aware of any country, including Germany, that is involved at this point.

Jane continued with the assumptions made in relating an inhalation study to an oral route of evaluation. Currently data is not available regarding possible differences in metabolism between oral and inhalation routes, as well as possible differences between human and animal metabolic pathways. NSF is trying to assess an appropriate absorption rate for THF via inhalation. Currently an assumption of 100% absorption is used in the NSF assessment, but previous assessments had assumed only 50% absorption. Ed Ohanian stated that it is not reasonable to assume 100% absorption via inhalation for any chemical. Carrol Voss asked what is the significance of using 50% absorption versus 100%. Jane explained that it means the exposed

animals absorbed only 50% of the administered dose, so the same toxic effects at were produced at only 50% of the administered dose (assuming 100% absorption is a less conservative approach). Carrol asked what is the basis of the 50% assumption. Lori said that the 50% was previously used based on a study of the inhalation absorption of 60 solvents, some of which had properties similar to THF. The group briefly discussed how the inhalation absorption of a chemical is actually measured.

Jane continued with discussion about assumptions used in the calculation of the STEL, MDWL, and MAL in the draft MAL assessment. She agreed with Sree Jasti's earlier suggestion that the LMS model is not the best to use for this chemical given the apparent lack of genotoxicity. Ed Ohanian added that genotoxicity is but one of several factors that should be considered when determining the appropriate model. It was agreed that mechanistic data would help support the selection of the appropriate model. Jane also asked the group to consider the level of risk to which the assessment should protect. Aside from solvent cements, other sources of THF in the distribution system are very limited, and a multiple source factor other than 10x might be justified. Bob Hinderer said that the use of the 10x safety factor is a major oversimplification. Possibly it should be 2 or 3. Jane added that for the mouse liver tumor endpoint, using terminal versus overall cancer rates doesn't appear to be significant, since the same action level is calculated when significant digit adjustment is applied. Neil Krivanek added that the terminal versus overall cancer rate would be significant if life shortening tumors were observed, but that doesn't appear to be the case in this study.

Discussion of Next Steps/Scheduling of Subsequent Activity

Andrea suggested that the group discuss in more detail the plans for acquisition of further data. Andrea said that NSF would be a willing participant in performing a controlled extraction study to acquire longitudinal data on THF extraction from cemented joints. She also offered that future meetings of this group will be held at the group's discretion. Andrea suggested that Jane and Lori could be available to attend any PPFA or THF Task Force meetings at which NSF's attendance would be beneficial. Chuck Bush stated that if further extraction study of THF is required, PPFA would like to be involved. Andrea said that the most efficient way to acquire the data would be to form a small task group to design and oversee the performance of the study.

Kavsy Dastur stated that the THF task Force has commitments from almost all of its members supporting the performance of a 2-3 phase research program on THF. The initial phase is to study mechanism and metabolism of THF. BASF in Germany will do the mechanistic studies, and DuPont the metabolism studies. The initial phase of studies will start this summer, with a goal of completion by early 1998. At the time of completion, the THF Task Force will conduct a workshop, including other stakeholders, to review the findings. The workshop and review will also serve to design phases 2 and 3 of the research program. Over the three phases the Task Force expects to spend about $500,000, so the Task Force commitment is vital. The group also recognizes the importance of involving other stakeholders early in the process. The Task Force wants EPA to review the research and provide guidance so that the data will be of value to various regulatory groups. NSF will be kept informed of what is going on periodically, and will be invited to these sessions. The Task Force wants this process to be very open. Sree said the phase one protocols will be submitted to NSF for review.

The group again reviewed Sree Jasti's overhead outlining the research program. Neil Krivanek said that the initial studies proposed are "standard procedure" that has been followed when trying to evaluate contradictory data in the past. The endpoints that need to be evaluated (α-2 microglobulin in rat kidney and non-genotoxic mechanism in mouse liver) have been investigated previously, so this research program can be very focused based on previous similar experiences. The timing and the dollars are pretty good estimates. When the phase 1 data is reviewed, phase 2 will investigate the species differences and pharmacokinetics. Modeling systems are unclear at this time, since the data must be generated to determine the appropriate model. Neil added that this data is currently lacking because this chemical was thought to be relatively benign until the NTP study was released. Kavsy Dastur added that a position paper will be drafted that will describe the

questions that are being asked about THF, and the Task Force intends to supply the position paper to all stakeholders. Lori, Sree, and Ed Ohanian discussed aspects of the proposed research program and what information each study would provide. The hypothesis is that the hepatocarcinogenicity and nephrocarcinogenicity of THF in rodents is secondary to cytolethality and regenerative cell proliferation. If this is correct, it means that a threshold level exists.

Kavsy Dastur asked for an explanation of the HETG's role in this process, and whether their participation is the follow-up plan is required. Andrea explained that historically the HETG is a group that worked very closely with NSF during the development of 60 and 61. The group is an advisory body to NSF, and primarily served to develop the health effects criteria in the Standards and advise NSF on other health-effects related matters. Jane said that she has talked to Ed Ohanian and Bob Hinderer about participation, as both had been members previously. Jane said that in the past the industry participation has not been from knowledgeable toxicologists, and she would like to see this change. Bob Hinderer said that the chairman used to be Richard Bull from Washington State University. Jane said that he has since moved on to work for Batelle, a contract laboratory, which is outside of the traditional stakeholder groups NSF brings together. Ed emphasized that the membership of this group is very important, and should represent a variety of areas of expertise as well as stakeholder groups. Bob asked if NSF would like to have nominations and Jane said that they would be welcomed. Bob added that historically the HETG set up the requirements for 60 and 61, but now more specific health effects issues need to be considered. Andrea said that the meetings of the HETG would not be closed, and representatives from the THF task group would be welcome to attend. She added that over the next few years she anticipates several MALs being discussed, in addition to THF. Andrea reminded the group that NSF is committed to publishing its MALs in stages as an informative annex to the standards. As consensus on the MALs is built, it would be desirable to have the Joint Committee ballot the MALs into the standards. In the short run this will not be an issue.

Chuck Bush said that PPFA is forming a subgroup to review issues related to the NTP THF study. A meeting is scheduled for July 23 for this group. Chuck will raise the issue of pursuing the additional extraction studies at this meeting, and he will contact Andrea following the July 23 meeting to discuss how to proceed.

ATTENDANCE RECORD

NSF International

MEETING TASK GROUP ON THF — HELD AT NSF INTERNATIONAL

DATE July 10, 1997

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ATTENDANCE RECORD

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M

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT M

British Standards Institute, "Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of water, Part 4. Method of Test - The GCMS identification of water leachable organic substances" 1998

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Part 4 : 1997

Incorporating
Amendment No. 1

Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water

Part 4. Method of test — The GCMS identification of water leachable organic substances

ICS 13.060.20

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Committees responsible for this British Standard

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Association of Manufacturers of Domestic Electrical Appliances
Automatic Vending Association of Britain
British Bathroom Council
British Cement Association
British Iron and Steel Producers' Association
British Malleable Tube Fittings Association
British Non-ferrous Metals Federation
British Plastics Federation
British Plumbing Fittings Manufacturers' Association
British Rubber Manufacturers' Association Limited
British Valve and Actuator Manufacturers' Association
British Water
Cadmium Association
Department of the Environment (Drinking Water Inspectorate)
Department of the Environment for Northern Ireland
Ductile Iron Producers' Association
Galvanizers' Association
Institute of Plumbing
Laboratory of the Government Chemist
Lead Development Association
Pipeline Industries Guild
Pipeline Protection Association
Scottish Association of Directors of Water and Sewerage Services
UK Water Byelaws Scheme
Water Research Centre
Water Services Association of England and Wales
Zinc Development Association

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Amd. No.	Date	Text affected
9971	March 1998	See Foreword

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Foreword

This Part of this British Standard has been prepared by Subcommittee EH/3/7.

Subsection 3, contained within the previously published BS 6920 : Section 2.5 : 1990, has been extended and developed into this Part of this British Standard and now incorporates greater experimental detail than before. BS 6920 : Section 2.5 : 1990 has already been withdrawn and is superseded by BS 6920 : Section 2.5 : 1996.

BS 6920 is published in several Parts, namely Part 1. *Specification*, Part 2. *Methods of test* and Part 3. *High temperature tests.*

Part 2 is further subdivided into a number of Sections and Subsections as follows:

Section 2.1	*Samples for testing*
Section 2.2	*Taste of water*
Subsection 2.2.1	*General method of test*
Subsection 2.2.2	*Method of testing tastes imparted to water by hoses*
Subsection 2.2.3	*Method of testing tastes imparted to water by hoses for conveying water for food and drink preparation*
Section 2.3	*Appearance of water*
Section 2.4	*Growth of aquatic micro-organisms*
Section 2.5	*The extraction of substances that may be of concern to public health*
Section 2.6	*The extraction of metals*

Amendment No. 1

In clause **11**, list item k) has been amended to read 'µg/l' instead of 'mg/l' wherever it occurs.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Introduction

WARNING. The tests described in this Part of BS 6920 should only be carried out by suitably trained and skilled persons with experience in the use of the various techniques utilized.

Chemicals that leach from materials used in contact with public water supplies can be of concern to the health of consumers. Potential health effects of these chemicals are assessed in three stages:

- preparation of leachates by exposing a portion of the material to water under controlled conditions;
- analysis of the leachates;
- toxicological evaluation of the concentrations of substances identified.

Analysis of organic substances present in the leachates usually involves two types of analytical methods:

1) a screening method which enables a qualitative and semi-quantitative assessment to be made of unspecified organic compounds;

2) accurate quantitative methods for the determination of specific target compounds known to be present in the chemical formulations of the materials.

This Part of BS 6920 describes the analytical procedures used to screen leachates for unspecified organic compounds derived from finished products such as pipes, protective coatings, membranes etc.

This method is suitable for all non-metallic materials that may be used in contact with water for human consumption, and which may be the subject of an application for approval by the national regulator.

NOTE 1. At the time of publication, products for use in contact with public water supply must be approved by the Secretary of State for the Environment under the provisions of regulation 25(1)(a) of the Water Supply (Water Quality) Regulations 1989 [1], unless any of the subsections 25(1)(b), (c) or (d) applies. The methods described in this section of BS 6920 may form the basis of leaching test specifications issued by the Committee which advises the Secretary of State on the approval of substances and products for use in contact with public water supplies. Equivalent provisions apply in Scotland and Northern Ireland.

NOTE 2. The results of these tests are assessed by reference to existing toxicological data concerning the chemicals identified. Where little or no information exists it may be necessary for the substance itself or the material leachate to be submitted for toxicity testing.

1 Scope

This Part of BS 6920 describes a method for identifying organic chemicals which are amenable to GCMS analysis using the techniques described and which may leach from a product into water intended for human consumption. A method of calculating the concentrations of the organic substances identified is also provided.

This Part of this British Standard is not applicable to the toxicological evaluation of chemicals.

2 References

2.1 Normative references

This Part of BS 6920 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publications apply to the British Standard only when incorporated in the references by amendment or revision. For undated references the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions and symbols

3.1 product

A manufactured item, in its finished form, that comes into contact with water, including a component part of a manufactured item.

3.2 composite product

A product where the water contact surface is made from a material that differs from those comprising the remainder of the product.

3.3 test sample

A product, or a part of a product, submitted for testing for suitability for use in contact with water intended for human consumption.

3.4 GCMS

An analytical instrument comprising a gas chromatograph (GC) linked to a mass spectrometer (MS).

3.5 GCMS general survey analysis

The acquisition of a series of mass spectra (up to several thousand) during the course of a gas chromatographic run, by operating the mass spectrometer in a continuous cyclic scanning mode over a wide *m/z* (see 3.14) range.

3.6 leachate

The aqueous solution that results from leaving test water (see 5.3 and 5.4) in contact with the sample (see 3.3) under the specified test conditions.

3.7 solvent extract

A solution containing compounds partitioned from the leachate into the extraction solvent (in this case dichloromethane).

3.8 procedural blank

A test water sample for laboratory tests, known to contain negligible levels of contamination, treated in the same way as the leachate but which does not come into contact with the material tested, and analysed in the same way as the leachate.

NOTE. Procedural blanks are used to check for potential contamination of either leachates or solvent extracts during the whole of the procedure, from extract preparation to analysis.

3.9 laboratory blank

A water sample known to contain negligible levels of contamination, to which internal standards have been added and which is then analysed in the same way as the leachate.

NOTE. Laboratory blanks are used to check for potential contamination of either leachates or solvent extracts which may occur within the laboratory during analysis.

3.10 total ion current (TIC)

The sum of all the separate ion currents carried by the individual ions contributing to a mass spectrum.

3.11 TIC chromatogram

A graphical representation of the TIC versus time.

3.12 electron impact ionization

Ionization by a beam of electrons.

3.13 mass spectrometric resolution

A measure of the capability of the mass spectrometer to correctly distinguish two mass spectral peaks, having similar mass to charge (m/z) values (see **3.14**), as separate peaks. When $z = 1$, this is generally denoted by $m_2/m_2 - m_1$ where m_2 has the higher m/z value and m_1 has the lower m/z value.

NOTE. A mass spectrometer set up so that the resolution is 650 will satisfactorily resolve and assign the correct masses to mass spectral peaks at m/z 649 and m/z 650.

3.14 *m/z*

The mass-to-charge ratio of an ion.

NOTE. As most ions produced by electron impact ionization are singly charged, this ratio usually corresponds to the mass of an ion. However, exceptionally, ions may possess multiple charges.

3.15 amu

The atomic mass unit; defined as 1/12 of the mass of a single atom of carbon-12 in the gas phase (i.e. unbound), at rest and in its ground state.

3.16 asymmetry factor A_s

A measure of the adsorption of a compound during gas chromatographic analysis. It may be derived from the equation

$$A_s = (a + b)/2b$$

where

a is the distance from the leading edge of the peak at the point on the baseline at which a perpendicular dropped from the peak maximum crosses it;

b is the corresponding distance from the trailing edge of the peak.

3.17 internal standards

Organic compounds added to the leachate at a known concentration prior to the commencement of the analysis.

NOTE. Internal standards are added for the following reasons: (a) to demonstrate that the analysis has been undertaken successfully, and (b) to provide a reference to allow other substances detected to be quantified. Ideally, the internal standards should not be present in the leachate; for this reason, isotopically labelled standards are preferred.

4 Principle

The test sample is either immersed in or filled with test water for a 24 h period.

The leachate is collected and a mixture of internal standards added prior to solvent extraction with dichloromethane. The solvent extract is concentrated and analysed by GCMS to determine the identity and approximate concentrations of organic chemicals which may be present.

The mass spectrometer is used in a repetitive full-scan mode and the mass spectra produced are recorded by, and stored on, the GCMS data system.

Wherever possible each compound detected is identified and may be quantified by reference to the responses obtained for the internal standards.

NOTE. The methods used to identify organic compounds from their mass spectra do not form part of this method, but further information on this subject is given in annex C.

5 Reagents

5.1 *General*, only reagents of analytical grade shall be used, except where specified otherwise. All reagents shall be of sufficient purity to ensure that they do not give rise to interferences during the GCMS analysis.

NOTE. Contamination may arise from various sources e.g. plastics or rubber materials. The use of procedural blanks and laboratory blanks assists in detecting and identifying the source of any contamination.

5.2 *Tap water*, obtained from a tap connected directly to a service pipe at mains pressure and having a free chlorine content of less than 0.2 mg/l.

5.3 *Test water*, prepared as follows.

Obtain the test water by reverse osmosis, deionization or distillation, followed by activated carbon filtration, having a conductivity of < 2 MS/m, a total organic carbon content of < 0.2 mg/l carbon, and free from organic contaminants which may interfere with the GCMS analysis of the extracts.

NOTE. For a batch of test samples a single batch of test water should be used for preparation of all extracts and procedural blanks; the volume of water should be sufficient to perform the specified pre-washing.

5.4 *Chlorinated test water*, use test water in accordance with **5.3**, having a free residual chlorine content of (1 ± 0.2) mg/l (see **5.12**). Determine the free residual chlorine content in accordance with BS 6068 : Section 2.26.

5.5 *Hydrochloric acid*, concentrated (30 % *m/V*).

5.6 *Hydrochloric acid solution*, prepared as follows.

Slowly add (0.5 ± 0.01) l of concentrated hydrochloric acid (see **5.5**) to (0.5 ± 0.01) l of test water (see **5.3**).

NOTE 1. Care is needed in preparing this solution which may generate heat.

NOTE 2. This solution should be replaced on a monthly basis.

5.7 *Nitric acid*, concentrated (65 % *m/V*).

5.8 *Nitric acid solution*, prepared as follows.

Slowly add (0.5 ± 0.01) l of concentrated nitric acid (see **5.7**) to (0.5 ± 0.01) l of test water (see **5.3**).

NOTE. Care is needed in preparing this solution which may generate heat.

5.9 *Sulfuric acid*, concentrated (98 % *m/V*).

5.10 *Sulfuric acid solution (0.5 mol/l)*, prepared as follows.

Slowly add (14.0 ± 0.5) ml of sulfuric acid (see **5.9**) to (300 ± 5) ml of test water (see **5.3**) and make up to (500 ± 5) ml with test water.

NOTE. Care is needed in preparing this solution which may generate heat.

5.11 *Chromic acid (5 % m/V)*, prepared as follows.

Dissolve (50 ± 1) g of chromium (VI) oxide in (1 ± 0.02) l of sulfuric acid (see **5.9**).

NOTE. Chromic acid is a storage hazard; it may burst a sealed container due to carbon dioxide release. It is a powerful oxidizer and may give potentially explosive reactions with oxidizable materials. It may ignite on contact with acetone or alcohols. When heated to decomposition it emits acrid smoke and irritating fumes.

5.12 *Sodium hypochlorite*, prepared as follows.

Prepare from a commercial solution of sodium hypochlorite (NaOCl) and having a known concentration of about 0.1 % by mass of free chlorine.

NOTE. Sodium hypochlorite solution is unstable and should be prepared on the day of use.

5.13 *Sodium hydroxide solution (0.5 mol/l)*, prepared as follows.

Dissolve (20.0 ± 0.1) g of sodium hydroxide pellets in test water and make up to 1 l.

NOTE. Replace this solution on a monthly basis.

5.14 *Dichloromethane*, glass distilled grade.

NOTE. Other grades may be suitable but it is necessary to demonstrate that any impurities present do not interfere with the detection of compounds of interest or the internal standards, or introduce unacceptable contamination.

5.15 *Acetone*, glass distilled grade.

NOTE. Other grades may be suitable but it is necessary to demonstrate that any impurities present do not interfere with the detection of compounds of interest or the internal standards, or introduce unacceptable contamination.

5.16 *Ascorbic acid solution*, prepared as follows.

Dissolve (4.0 ± 0.1) g of ascorbic acid in (1.0 ± 0.01) l test water. Prior to use, extract this solution with dichloromethane (2 × 200 ml).

NOTE. Replace this solution on a monthly basis.

5.17 *Internal standards*, use the following isotopically-labelled compounds:

d_6-benzene;

d_{21}-2,6-di-t-butyl-4-methylphenol (d_{21}-BHT);

d_5-chlorobenzene;

d_{34}-hexadecane;

d_8-naphthalene;

d_{10}-phenanthrene;

d_6-phenol;

d_{62}-squalane;

d_{10}-p-xylene.

5.18 *Internal standards stock solutions*, prepared as follows.

Make up in acetone (see **5.15**) as follows:

d_6-benzene	(2.0 ± 0.05) mg/ml;
d_{21}-BHT	(8.0 ± 0.20) mg/ml;
d_5-chlorobenzene	(2.0 ± 0.05) mg/ml;
d_{34}-hexadecane	(1.0 ± 0.02) mg/ml;
d_8-naphthalene	(1.0 ± 0.02) mg/ml;
d_{10}-phenanthrene	(2.0 ± 0.05) mg/ml;
d_6-phenol	(8.0 ± 0.20) mg/ml;
d_{10}-p-xylene	(1.0 ± 0.02) mg/ml.

NOTE 1. Due to its volatility it is difficult to make standard solutions of d_6-benzene by weighing; it is recommended that suitable volumes (measured using micro-syringes) of d_6-benzene, based on its density (0.950), are used.

Make up the following stock solution in dichloromethane (see **5.14**):

d_{62}-squalane	(8.0 ± 0.20) mg/ml.

NOTE 2. The stock solutions are stable for at least six months, provided they are stored in the dark at (−18 ± 5) °C.

5.19 *Internal standards intermediate solution*, prepared as follows.

Place (2.5 ± 0.025) ml of the d_{62}-squalane stock solution in a 25 ml volumetric flask. Remove as much as possible of the dichloromethane using nitrogen blow-down. Then put (2.5 ± 0.025) ml of each of the remaining individual standard stock solutions (see **5.18**) into the volumetric flask, ensuring that the d_6-benzene stock solution is added last, and make up to the graduation mark with acetone (see **5.15**).

NOTE 1. The d_6-benzene stock solution is added last in order to minimize any potential evaporative losses of this standard.

NOTE 2. This solution is stable for at least six months provided it is stored in the dark at (−18 ± 5) °C.

5.20 *Internal standards GC column test solution*, prepared as follows.

Add (200 ± 5) µl of the internal standards intermediate solution (see **5.19**) to (8 ± 0.5) ml of dichloromethane (see **5.14**) in a 10 ml volumetric flask, then make up to the graduation mark with dichloromethane (see **5.14**).

NOTE 1. To avoid potential losses of the most volatile internal standard (d_6-benzene) it is recommended that a syringe fitted with a needle of sufficient length to allow the tip to be introduced below the meniscus of the dichloromethane prior to expelling the syringe contents is used.

NOTE 2. This solution should be renewed every three months, or sooner if during its use, an indication is obtained that the concentrations of any of the internal standards have changed.

5.21 *Internal standards spiking solution*, prepared as follows.

Add (1.00 ± 0.01) ml of the internal standards intermediate solution (see **5.19**) to (8 ± 0.5) ml acetone (see **5.15**) in a 10 ml volumetric flask, then make up to the graduation mark with acetone (see **5.15**).

NOTE. This solution should be renewed every three months, or sooner if during its use any indication is obtained that the concentrations of any of the internal standards have changed.

5.22 *Sodium sulfate (anhydrous)*, prepared as follows.

Remove any organic contaminants by heating at (500 ± 50) °C for ≥ 4 h, and store so that rehydration is minimized and re-contamination cannot occur.

6 Apparatus

6.1 *Vessels, containers, stoppers and connectors*, constructed of a material such as glass, polytetrafluoroethylene (PTFE) or stainless steel, that is inert under the specified test conditions.

6.2 *Cleaning*, in accordance with the following procedure.

Laboratory glassware, as well as stainless steel and glass plates, shall be cleaned by washing with a biodegradable laboratory detergent specially designed for the removal of organic materials, followed by rinsing with hydrochloric acid solution (see **5.6**) (except for stainless steel), nitric acid solution (see **5.8**) or chromic acid (see **5.11**), and finally by thoroughly rinsing with test water (see **5.3**).

6.3 *1 litre borosilicate glass bottles*, of nominal capacity 1 l, fitted with either ground-glass stoppers or screw-top caps with PTFE or PTFE-faced liners.

6.4 *Concentration apparatus*, which is specifically designed to allow the solvent extract (see **3.7**) to be reduced in volume from 200 ml to (50 to 500) µl.

NOTE. Various commercial equipment (such as Kuderna-Danish or Turbovap apparatus) may be suitable, but during this operation (which may proceed in several steps) it is essential that losses of volatile compounds are minimized. The response of the most volatile internal standard (d_6-benzene) should be checked to ensure that losses of this compound in the concentration step do not exceed 50 %. One method of checking for losses is given in C.2.

6.5 *Instrumental*

6.5.1 *Capillary gas chromatograph*, with temperature gradient facility interfaced to a mass spectrometer (see **6.5.4**).

6.5.2 *GC capillary column*, fused silica having a length of at least 50 m, with an internal diameter of 0.25 mm or 0.32 mm, coated with a non-polar bonded phase which performs equivalently to dimethylsilicone gum (e.g. DB-1 or BP-1).

6.5.3 *Carrier gas (for GCMS system)*, helium (99.999 % purity, or better).

6.5.4 *Mass spectrometer*, which is capable of operating in the electron impact ionization mode covering the *m/z* range 20 to 650 provided that the mass spectrometric resolution (see **3.13**) is sufficient to allow unit mass resolution at the highest mass recorded with a scan cycle of ≤ 1 s.

6.5.5 *Mass spectrometry data system*, which is capable of acquiring data from the mass spectrometer under the conditions in **6.5.4**, and which can produce total ion current (TIC) chromatograms, background-subtracted averaged mass spectra and TIC peak areas. It shall also be capable of producing hard-copy outputs of TIC chromatograms and mass spectra.

6.5.6 *Mass spectral library*, if a mass spectral library is not available on the mass spectrometry data system (see **6.5.5**) alternative hard-copy documents shall be available.

NOTE. Examples of alternative hard-copy documents are the 'Eight Peak Index of Mass Spectra' [2] or the 'Registry of Mass Spectral Data' [3].

7 Samples

7.1 Sample storage

Store test samples in the absence of light at (21 ± 4) °C and in an environment free of contamination, e.g. metal boxes or containers, or wrapped in unglazed non-pigmented tissue paper.

7.2 General requirements

Test samples shall comply with all the relevant requirements given in BS 6920 : Section 2.1, with the exceptions detailed in **7.3** to **7.5**.

7.3 Surface area to volume ratio *(S/V)*

Use a ratio of 1 cm^2 test surface area of the sample in 1 cm^3 of test water (this can be expressed as 1 cm^{-1}).

If it is impossible to achieve this *S/V* ratio use the nearest achievable ratio and include this ratio in the test report (see clause **11**).

NOTE. The *S/V* ratio used for pipe samples will be determined by the internal diameter of the pipe (see **7.4**).

The same *S/V* ratio shall be used in tests intended to be comparable.

7.4 Pipes and factory applied pipe linings

Test the pipe which has the smallest diameter for which approval is sought.

7.4.1 *Pipes with internal diameters of ≤ 100 mm*

Use samples with a length which provides a sufficient volume of leachate for analysis. Completely fill the sample with test water (see **5.3** or **5.4**) so that there is no unfilled head-space and close both ends with suitable stoppers (see **6.1**) or plates.

NOTE. Annex A gives details of two methods which can be used for sealing the ends of test pipe lengths.

7.4.2 *Pipes with internal diameters of > 100 mm*

For pipes made from homogeneous materials, immerse segments of pipe in test water so as to give a test *S/V* ratio of 1 cm^{-1}. For composite material pipes, or for testing pipe linings use a test arrangement giving a *S/V* ratio of 1 cm^{-1}.

NOTE 1. Annex B provides details of suitable methods.

NOTE 2. If a pipe with an internal diameter of > 100 mm is filled with test water it will give an *S/V* ratio of < 1 cm^{-1}.

7.5 Cementitious products

Prepare test samples in accordance with **4.2.8** of BS 6920 : Section 2.1 : 1996, having a total surface area of (15 000 ± 500) mm^2 each, but use only three 24 h sequential soak periods in contact with non-aggressive water before starting the leaching tests. Test each test sample using 1 l of test water.

8 Test procedure

8.1 Preparation of test leachates

Carry out this test using both types of test water (see **5.3** and **5.4**).

8.2 Pre-treatment of samples

Rinse the test samples according to **10.4** of BS 6920 : Section 2.5 : 1996 on the same day as testing is to start. Then rinse them with test water (see **5.3** or **5.4** as appropriate) for 2 min to 5 min. Start the test immediately after pre-treatment of the sample (see **3.3**).

8.3 Production of leachates

Prepare leachates from whole samples in accordance with **10.4** of BS 6920 : Section 2.5 : 1996, with the following exceptions:

- use test water (see **5.3** and **5.4**) in place of tap water;
- use a surface area to volume test ratio conforming to **7.3** of this standard;
- fill test vessels completely and seal adequately to prevent loss of volatile substances.

Fill test pipes which have internal diameters of 100 mm (see **7.4.1**) with test water (see **5.3** and **5.4**). For larger diameter pipes (> 100 mm) immerse in or fill with the test water (see **5.3** and **5.4**) in accordance with **7.4.2**.

Store for a period of (24 ± 1) h at (23 ± 2) °C and at the end of this period collect the leachates for analysis (see **8.4**).

8.4 Collection of leachates

When collecting a sample of leachate rinse the bottle (see **6.3**) with a portion of the leachate before collecting the sample for analysis. Completely fill the bottle so that there is no head space above the sample.

NOTE. This is to prevent the loss of volatile components from the sample.

When collecting samples of leachates produced using chlorinated test water (see **5.4**), add 2 ml of ascorbic acid solution (see **5.16**) to the sampling bottle after rinsing the bottle with a portion of the leachate, but before collecting the sample as above.

NOTE. For leachate samples produced using test water (see **5.3**) there is no requirement to add ascorbic acid.

8.5 Storage of leachates

Start the analysis of leachate samples as soon as possible following sample collection. If necessary store the leachate samples in the absence of light at (4 ± 2) °C for a maximum of 48 h before solvent extraction is undertaken.

8.6 Procedural blank tests

Carry out a blank test procedure with each batch of test samples using the same test conditions (test water, test temperature, leaching periods, type of test vessel, stoppers etc.) as described in **8.3**, but omitting the test sample(s).

When only glass stoppers or stainless steel plates are used to seal pipe test pieces, a glass container is suitable for the procedural blank; when other articles, such as stoppers, connectors or sealants are used (e.g. PTFE, silicone sealant etc.) include these in the procedural blank at the same *S/V* ratio as the exposure in the test containers.

9 Method of analysis

9.1 Extraction procedure

SAFETY NOTE. During the solvent extraction step, excess pressure which may build up in the stoppered separating funnel should be dissipated via the separating funnel tap when the separating funnel is inverted. As dichloromethane vapour is hazardous, dissipation of pressure should be undertaken with the separating funnel in a fume hood.

Transfer 1 l ± 10 ml of the leachate sample (see **8.4**) to a 2 l separating funnel.

Add (100 ± 2) µl of the internal standards spiking solution (see **5.21**) into the sample using a syringe, ensuring that the tip of the syringe needle is below the surface of the sample. Insert the stopper and swirl the contents of the separating funnel to mix.

Check the pH of the sample and adjust to pH 2 ± 0.2, if necessary, by dropwise addition of either sulfuric acid solution (see **5.10**) or sodium hydroxide solution (see **5.13**) as appropriate.

Add dichloromethane (100 ± 5) ml to the spiked pH adjusted sample in the separating funnel and insert the stopper. Shake the separating funnel for a total of 3 min ± 20 s. Remove the dichloromethane (lower layer) into a flask (capacity at least 250 ml). Add a further (100 ± 5) ml of dichloromethane to the separating funnel and repeat the extraction step. Add the second aliquot of dichloromethane to the flask in which the initial solvent extract is stored, so that the two extracts are combined.

Dry this combined solvent extract, then transfer it to the apparatus to be used for concentration of the extract and reduce it to a small volume (100 µl to 500 µl). Store the concentrated extract in a freezer at (−18 ± 5) °C or below until the GCMS analysis is carried out.

NOTE 1. Do not shake the contents of the separating funnel vigorously following addition of the internal standards spiking solution; doing so (in the absence of the extracting solvent, which is added later) will result in losses of the more volatile internal standards.

NOTE 2. Various methods may be suitable for drying solvent extracts e.g. freezing or addition of small amounts of sodium sulfate (see **5.22**). Any of these may be used provided that they do not affect adversely the performance of this method.

9.2 GCMS analysis

SAFETY NOTE. GCMS systems typically operate from a nominal mains voltage (220 V to 240 V a.c.; exceptionally, some operate from a '3-phase' 415 V a.c. supply). However, certain parts or components of some mass spectrometers (which utilize a magnetic field for mass resolution) may be at a very high electrical potential (up to 8 kV) relative to earth; other mass spectrometers utilize radio-frequency radiation and d.c. voltages for mass separation. Due care is necessary in the operation of GCMS systems.

9.2.1 *Mass spectrometer operating parameters*

Follow the manufacturer's instructions for the mass spectrometer to set the following parameters:

Ionization mode:	electron impact (EI);
Electron energy:	70 eV;
Mass range:	to include 20 amu to 650 amu;
Scan speed:	≥ 1 scan per second;
Scan mode:	repetitive.

9.2.2 *Setting up the mass spectrometry data system*

Follow the manufacturer's instructions relating to optimizing the performance and sensitivity of the mass spectrometer, mass calibration and data acquisition and processing.

9.2.3 *Initial tuning and mass calibration of the mass spectrometer.*

Follow the manufacturer's instructions. All of the major reference peaks in the mass range covered in the calibration table held on the MS data system shall be found in the scan(s) used for calibration purposes.

NOTE. Major reference peaks are those having an intensity > 5 % of that of the base peak (which by convention is assigned an intensity of 100 %) of the calibrant used.

9.2.4 *Setting up the GCMS system*

Install the GC column according to the manufacturers' instructions and verify its performance (e.g. in terms of separation number and adsorption) against the column performance data supplied by the manufacturer.

NOTE. Proprietary standard solutions are available for this purpose (see **C.4**).

Provided the general performance of the column is satisfactory, use the internal standards GC column test solution (see **5.20**) to establish the initial performance of the column for the internal standards. Use the same GC temperature programme for this purpose as that used for the GCMS analysis of the concentrated solvent extracts (see **9.1**).

Ensure the temperature programming rate does not exceed 12 °C/min at any time.

Ensure that all of the internal standards are detected on the TIC chromatogram.

Ensure the d_6-benzene is separated from the solvent peak and ensure the retention time of d_{62}-squalane is between 35 min and 45 min.

Ensure that the asymmetry factors, A_s, (see **3.16**) for the peaks obtained for d_5-phenol and d_8-naphthalene are within the range 0.67–2.0. If this requirement is not met, investigate the cause and correct before continuing with the analysis. If necessary install a new GC column.

Adjust the sensitivity of the mass spectrometer so that the mass spectra obtained for the internal standards present at the highest level (16 ng/µl) in the internal standards GC column test solution are not saturated.

Inspect the mass spectra obtained from the GCMS system performance test to ensure that they correspond closely to mass spectra previously acquired for these internal standards on the same GCMS system under identical operating conditions. Ensure that the *m/z* value of the base peak is consistent, and that the intensities of all peaks having an intensity > 10 % of the base peak do not vary by more than 30 % of their intensity when compared to previously acquired spectra.

If the internal standards GC column test solution has not previously been analysed, analyse it once a day on the GCMS system on five separate days to obtain typical spectra of the internal standards.

Check the mass spectrometer mass calibration by inspecting the high mass ions (> *m/z* 300) in the mass spectra for d_{62}-squalane to ensure that they are correctly mass measured. If this is not the case recalibrate the mass spectrometer before continuing with the analysis.

NOTE. The requirements for the GCMS GC run-programme can be complied with by using a GC column of length 50 m to 60 m with an internal diameter of 0.32 mm, coated with a bonded phase equivalent to OV-1, an initial temperature of 30 °C for 4 min, linearly programmed at 8 °C/min to a final temperature of 300 °C and maintaining this for 20 min. Other conditions may also be suitable.

9.2.5 *GCMS operating conditions for analysis of solvent extracts*

Analyse concentrated solvent extracts using identical conditions to those used for checking the performance of the GCMS system using the internal standards GC column test solution.

Check the performance of the GCMS system at the end of every batch of concentrated solvent extracts run, or after every sixth concentrated solvent extract if batch sizes are greater than six.

Check the criteria in **9.2.4** to ensure that the performance of the system has not deteriorated. If the system is not in accordance with any of **9.2.4**, stop the analysis, investigate and correct the cause of the failure before continuing with the analysis.

9.2.6 *Production of required outputs from the GCMS data system*

Ensure the following outputs are obtained for each of the GCMS runs carried out on concentrated solvent extracts:

– a hard copy of the TIC trace (covering the mass range scanned);

NOTE. If a solvent delay is included as part of the data acquisition, the TIC trace will not include a peak for the solvent – this is acceptable.

– the retention times correct to ± 1 s, or the GCMS data system scan number, of the peak maximum of every peak detected on the TIC chromatogram, including the internal standards;

– the peak areas of every detected peak, including the internal standards;

– hard copies of a mass spectrum obtained for each of the compounds detected which are considered to originate from the sample; this shall be the best spectrum obtainable, normally obtained by background subtraction and averaging of several mass spectra.

NOTE. Compounds detected which are not considered to arise from the sample or which are not internal standards, are included in the above requirements. However, an indication should be given as to which of the compounds detected fall into this category, along with their probable origin e.g. contaminants in the solvent used for the solvent extraction, or compounds present in the test water.

10 Expression of results

10.1 Reporting of results

Tabulate the results from the GCMS analysis and include, for every peak detected on the TIC chromatogram:

a) the retention time or scan number;

b) its identity;

c) its estimated concentration (expressed in μg/l);

d) the internal standard used for quantification;

e) its probable origin.

10.2 Identification of compounds detected

Use three categories to define the confidence level associated with the identities of the detected compounds, as follows.

a) A positive identification (P) indicates that the mass spectrum and GC retention time are the same as those obtained from a pure standard of the compound run under the identical GCMS conditions on the GCMS system used to analyse the concentrated solvent extract.

b) A tentative identification (T) indicates that a possible identity has been obtained either from computerized library searching of a mass spectral data base, or from manual searching of a printed mass spectral data base, or by interpretation from first principles by a mass spectroscopist. However, a pure standard has either not been run under identical GCMS conditions on the GCMS system used to analyse the concentrated solvent extract or is not available.

c) An unknown (U) is any compound not covered by either of the above categories. The four most intense peaks in the mass spectrum, in decreasing order of intensity, with the base (100 %) peak being emphasized by underlining (e.g. 147, 43, 71, 91), should be noted in the tabulation of results together with the retention time or scan number.

NOTE. Further information on identification can be found in **C.1.**

10.3 Quantification of compounds detected

Quantify each detected compound by comparing its response to the nearest internal standard (in terms of GC retention time) present at 2 μg/l or 8 μg/l, with the exception of d_6-phenol, which is not used for quantification.

Use the following equation to provide the concentration of a compound D of each compound detected in a leachate sample:

$$[D] = \frac{P_D \times I}{P_S}$$

where:

$[D]$ is the concentration of a compound D (in μg/l);

P_D is the peak area of a compound D;

P_S is the peak area of the internal standard;

I is the internal standard concentration (in μg/l).

Make no attempt to adjust $[D]$ for extraction efficiency.

10.4 Quality assurance (QA) and quality control (QC) procedures

10.4.1 *The mass calibration of the mass spectrometer*

Verify on each occasion that a batch of concentrated solvent extracts is analysed. Use the calibrant normally used for mass calibration for this purpose. Recalibrate the mass spectrometer if any of the calibrant masses are incorrectly assigned.

10.4.2 *The performance of the GCMS system*

Check the performance of the GCMS system on each occasion that a batch of concentrated solvent extracts is to be run by analysing the internal standards GC column test solution (see **5.20**). Compare the response (peak area) obtained for each internal standard to that obtained when setting up the GCMS system (**9.2.4**). Provided that the peak areas are within 30 %, and the asymmetry factors are in accordance with **9.2.4**, consider the performance acceptable.

10.4.3 *The performance of the method*

Consider the performance of the method acceptable provided the following criteria are satisfied:

a) all of the internal standards are detected in the GCMS TIC chromatogram;

b) the recoveries of the internal standards d_8-naphthalene, d_{10}-phenanthrene and d_{62}-squalane are > 50 %.

NOTE 1. The absence of any of the internal standards in the GCMS TIC chromatogram indicates that either the extraction step has not been carried out correctly, or the concentration of the solvent extract has not been carried out correctly, or the GCMS system is not functioning correctly.

NOTE 2. A procedure for calculating the recoveries of internal standards is given in **C.3**.

11 Test report

The test report shall include the following particulars:

a) a reference to this Part of BS 6920;

b) the name and address of the laboratory undertaking the testing; the date(s) when the tests were carried out; the date on which the extraction of the leachates was carried out; the date of the report and a unique laboratory report number;

c) the trade name and reference of the product;

d) the general composition of the product;

e) the names of the product manufacturer, the submitting organization and the organization responsible for preparing the samples;

f) a full description of the samples including the surface area or dimensions of each sample, the number of examples constituting the samples and the volume of test water used;

g) a description of the method used to seal the ends of pipe samples, as appropriate;

h) the intended use of site applied products and, if applicable, the minimum temperature for application;

i) for site applied products, in addition to the information in a) to h), the details shall contain:

1) the names of primers and undercoats used, together with the wet film thickness of each coating applied;

2) a full description of the preparation and application of the product(s) including method of application to the test plates, nature of the test plates and full curing conditions used for primers, undercoats and top coats.

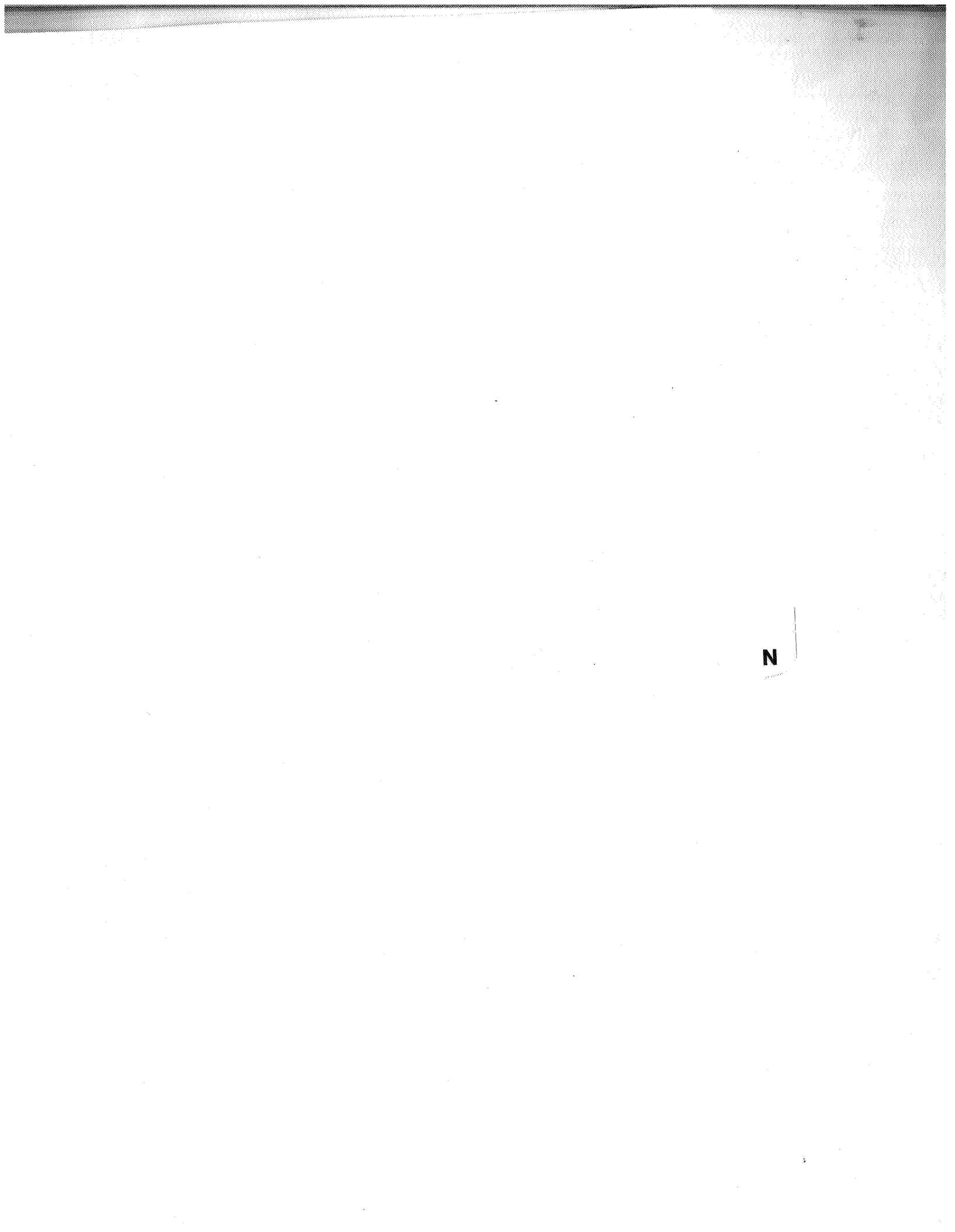
j) for cementitious products, in addition to the information in a) to h), the report shall contain:

1) the composition or trade name of the mortar/cement materials;

2) the aggressivity index of the pre-conditioning water (see **4.2.8** of BS 6920 : Section 2.1 : 1996);

3) the pH of the pre-conditioning water at the start and finish of each 24 h pre-conditioning period;

4) the pH of the leachate at the start and finish of each leaching period.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Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT N

Seinen, et al, "Toxicity of Organotin Compounds. II. Comparative in Vivo and in Vitro Studies with Various Organotin and Organolead Compounds in Different Animal Species with Special Emphasis on Lymphocyte Cyctotoxicity" April 4, 1977

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TOXICOLOGY AND APPLIED PHARMACOLOGY 42, 197–212 (1977)

Toxicity of Organotin Compounds. II. Comparative *in Vivo* and *in Vitro* Studies with Various Organotin and Organolead Compounds in Different Animal Species with Special Emphasis on Lymphocyte Cytotoxicity

WILLEM SEINEN, JOSEPH G. VOS,[1] INE VAN SPANJE, MARGRIET SNOEK, RUUD BRANDS, AND HERBERT HOOYKAAS

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Toxicity of Organotin Compounds. II. Comparative *in Vivo* and *in Vitro* Studies with Various Organotin and Organolead Compounds in Different Animal Species with Special Emphasis on Lymphocyte Cytotoxicity. SEINEN, W., VOS, J. G. VAN SPANJE, I., SNOEK, M., BRANDS, R., AND HOOYKAAS, H. (1977). *Toxicol. Appl. Pharmacol.* 42, 197–212. A series of organotin and organolead compounds were fed to male and female weanling rats for 2 weeks at dietary levels of 0, 50, or 150 ppm, in order to evaluate their toxic effects, with special emphasis on the thymus and peripheral lymphoid organs. A dose-related reduction in the weight of thymus, spleen, and popliteal lymph node, associated with lymphocyte depletion in the cortex of the thymus and the thymus-dependent areas in the peripheral lymphoid organs, was observed in animals fed di-*n*-octyltin dichloride (DOTC) and di-*n*-butyltin dichloride (DBTC). As shown previously, these effects were not related to stress. Similar; but less pronounced, lymphoid organ changes occurred in animals fed diets containing diethyltindichloride (DETC) and di-*n*-propyltindichloride. In contrast, other dialkyltin compounds (dimethyltindichloride; di-*n*-dodecyltindibromide; and di-*n*-octadecyltindibromide), as well as mono-*n*-octyltintrichloride (MOTC), tri-*n*-octyltinchloride, and tetraoctyltin did not cause atrophy of lymphoid organs. Of the dialkyllead compounds tested, di-*n*-butylleaddiacetate and di-*n*-hyxylleaddiacetate, the latter caused distinct lymphoid atrophy, but only when associated with severe growth retardation. A similar structure–activity relationship regarding thymus atrophy by dialkyltin compounds was observed after iv application. DOTC and DBTC were effective at a dose of 1 mg/kg. A dose-related reduction of thymus weight, cell count, and cell viability occurred in rats after a single iv injection of 0, 1, 2, 4, or 8 mg of DOTC/kg. The effect of DOTC was completely reversible. In contrast to rats, lymphoid atrophy did not occur in mice, guinea pigs, or Japanese quail fed DOTC or DBTC. *In vitro* incubation of thymocytes and bone marrow cells with DBTC and DOTC revealed the same selectivity regarding cell type and species origin of cells as was found *in vivo*. A dose-related decrease in the survival of rat thymocytes was observed, whereas rat bone marrow cells were not affected by DBTC and DOTC at levels up to 50 μg/ml. In contrast, the number and viability of mouse and guinea pig thymocytes exposed to DBTC were the same as the controls. As the survival of human thymocytes was markedly decreased by DBTC, it possibly acts in the same manner in man and rat. In agreement with *in vivo* results, the survival of rat thymocytes was not significantly decreased by dimethyltindichloride and diethyltindichloride.

The toxicity of organotin compounds has been reviewed by Barnes and Stoner (1959) and by Piver (1973), wherein no attention was paid to the effects of dialkyltin

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compounds on the lymphoid system. However, in a recent study (Seinen and Willems, 1976), it has been shown that the main effect of di-*n*-octyltindichloride (DOTC) in rats is on the thymus. Histologically, lymphocyte depletion was observed in the thymus and in thymus-dependent lymphoid areas of the spleen and lymph nodes in rats fed DOTC at levels of 50 and 150 ppm. Four weeks of feeding 50 and 150 ppm of DOTC reduced the total number of thymocytes by 67 and 94% respectively. The viability of these cells was also decreased in relation to the dose. The effect on spleen cell count and viability was less pronounced, whereas no effect was found on bone marrow cells. Since similar effects were found in adrenalectomized rats, the selective effect of DOTC on the thymus-dependent lymphoid tissue was not caused by stress-related release of glucocorticoids.

The present study deals with the relationship of chemical structure in organotin compounds and thymolytic acitvity in different animal species.

In short-term feeding tests, the influence of the degree of substitution (mono-, di-, tri-, and tetraoctyltin) and of the length of the alkyl chain was determined in disubstituted tin compounds. For comparison, the program included two organolead compounds. As a basis of reference to general toxicity of the compounds, effects other than those on lymphoid organs were studied as well, particularly the effects on the liver.

The relationship of alkyl chain length and toxicity appeared to be different with oral and intravenous routes of administration (Barnes and Stoner, 1958). Therefore, in addition to the oral feeding experiments, a selected number of dialkyltin compounds were administered intravenously to rats.

To investigate the reversibility of thymus atrophy induced by di-*n*-octyltindichloride in rats, a recovery experiment was conducted.

Finally, *in vitro* experiments are presented on the effects of di-*n*-octyl and di-*n*-butyltindichloride on thymus and bone marrow cells of different species, including man, and on the effects of various dialkyltin compounds in rat thymus cell cultures.

METHODS

The following organotin[2] and organolead[2] compounds were used in this study: dimethyltindichloride (DMTC), diethyltindichloride (DETC), di-*n*-propyltindichloride (DPTC), di-*n*-butyltindichloride (DBTC), di-*n*-octyltindichloride (DOTC), di-*n*-dodecyltindibromide (DDTB), di-*n*-octadecyltindibromide (DOTB), mono-*n*-octyltintrichloride (MOTC), tri-*n*-octyltinchloride (TOTC), tetra-*n*-octyltin (TOT), di-*n*-butylleaddiacetate (DBLA), and di-*n*-hexylleaddiacetate (DHLA). The purity of these compounds was not less than 98%.

Oral Treatment Studies

Randomized groups of 10 weanling male and/or female rats[3] (Wistar-derived, specific pathogen-free, weighing 45–50 g), 10 weanling male mice[3] (Swiss, specific pathogen-free, weighing 10–12 g), 10 weanling male guinea pigs[3] (Hartley strain, weighing 200–225 g), and groups of six Japanese quail[4] (weighing 70–80 g) were used.

[2] Kindly provided by Dr. E. J. Bulten, Institute for Organic Chemistry TNO, Utrecht, The Netherlands.
[3] Obtained from the Central Institute for the Breeding of Laboratory Animals TNO, Zeist, The Netherlands.
[4] Reared at the Institute of Veterinary Pharmacology and Toxicology.

The diets were prepared by mixing the compound with a commercial ration.[5] It was given as a meal to rats, mice, and quail, and as a 3-mm pellet to guinea pigs. Rats, mice, and guinea pigs were housed in plastic and quail in screen-bottom cages, at a room temperature of 23°C ± 2 and 50–60% relative humidity. Diets and tap water were constantly available. Individual body weights were recorded weekly. The duration of treatment was 2 or 4 weeks.

All animals that survived the experimental period were killed by decapitation and a necropsy was performed. Body weights and the weights of the thymus, spleen, popliteal lymph node, bursa of Fabricius, liver, kidneys, and adrenals were recorded. Samples of these organs were fixed in 10% buffered formalin and processed by conventional means for histopathological examination. Sections were stained with hematoxylin and eosin.

In the recovery experiment, 60 male rats were divided into two groups and fed 0 or 150 ppm of DOTC for 4 weeks. After that period, all animals were returned to stock diet to investigate the reversibility of DOTC-induced thymus involution. Thymus weights were determined in groups of five rats killed 0, 2, 7, 14, 28, or 56 days after treatment.

Intravenous Treatment Studies

For intravenous administration, the water-soluble dialkyltin homologs were dissolved in saline. For the water-insoluble dialkyltin homologes (chains of four or more C atoms), solutio petit[6] or Intralipid[7] were used as vehicles. The organotin compounds were dissolved in solutio petit as follows: The test compounds were first dissolved in 100% ethanol, then mixed with glycerol, and finally, with a syringe connected with a 25-gauge needle, injected into the distilled water while being swirled on a whorl mixer. The solution was checked for the presence of crystals by centrifugation (10,000 *g*, 10 min) and by polarization microscopy. The Intralipid solution was prepared by the method described by Fortner *et al.* (1975). Briefly, the tin compound was dissolved in 100% ethanol and carefully mixed with the Intralipid. This fat emulsion containing 2% ethanol was stable for 2 hr. Polarization microscopy revealed any tin compound crystals that were present.

Groups of five to eight female rats were used. The preparations were injected into the tail vein. Individual body weights were recorded before each injection and terminally. Animals were killed, 2 days after the last injection. The liver, kidneys, spleen, and thymus were weighed and processed for histopathological examination. In some experiments the total number of thymus lymphocytes and their viability were determined.

In Vitro Experiments

For the preparation of thymocyte suspensions, thymus glands from at least three animals (age 6–12 weeks) were removed under aseptic conditions and carefully trimmed free from the adjoining lymph nodes. Human thymus tissue was removed from children during thoracic surgery.[8] The tissues were sampled in cold RPMI 1640,[9] supplemented

[5] Rat and mice chow were obtained from Trouw and Co., Putten; guinea pig chow from Hope Farms, Woerden; and quail chow from Koopmans, Leeuwarden, all in the Netherlands.
[6] Solutio petit is a mixture of 26 parts ethanol, 33 parts glycerol, and 42 parts distilled water.
[7] Intralipid, Vitrum, Stockholm, Sweden.
[8] Performed by Professor Dr. H. A. Huysmans, Antonius Hospital, Utrecht, The Netherlands.
[9] Obtained from Gibco Biocult, Paisley, Scotland.

with 50 U of penicillin and streptomycin/ml[9] and 2 mM l-glutamine,[10] and minced with scissors in fragments which were gently pressed through a nylon sieve with a pore diameter of 220 μm. Bone marrow cells were obtained by flushing medium through the femoral marrow cavity which was directly passed through the nylon cell sieve.

To remove cell clumps, the suspensions were drawn through a 25-gauge needle, and the cells were washed twice. Two million cells were cultured in duplicate in a total volume of 0.5 ml of medium, in loosely capped polystyrene culture tubes[11] (12 × 75 mm). The medium was supplemented with 15% heat-inactivated (56°C for 30 min) serum. Cultures were incubated at 37°C in a humidified atmosphere of 5% CO_2 in air for periods up to 40 hr. Cell viability was determined in hemocytometers with a 0.05% nigrosin[12] solution in saline. At the start of the culture period cell viability was always more than 90%. Cells were counted with an electronic particle counter.[13]

Organotin compounds were dissolved in ethanol just before addition to the cell cultures. The final concentration of ethanol in the medium was 0.5%, a concentration that did not affect cell survival. The cytotoxicity of DBTC was tested at concentrations up to 50 μg/ml of medium. Cell viability and cell number were recorded after 0, 8, 16, and 24 hr of incubation. The incubations were carried out first in a medium containing isolog (rat, mouse) or homolog (guinea pig, man) serum. To find out whether or not the observed absence of cytotoxicity in guinea pig was due to binding of DBTC to serum proteins, thymocytes of man, rat, and guinea pig were also cultured with heterolog (fetal calf) serum. In addition, rat and guinea pig thymocytes were also cultured with their respective sera.

To compare the effects of various dialkyltin compounds *in vitro*, rat thymocytes were cultured with 0, 0.012, and 0.12 mM DMTC, DETC, DBTC, and DOTC, the highest concentrations being, respectively, 26, 30, 38, and 50 μg/ml. Cell count and viability were determined after 0, 8, 16, and 24 hr of incubation.

Rat bone marrow cells were cultured with 0, 5, or 50 μg of DBTC and DOTC/ml medium. Cell count and viability were recorded after 0-, 16-, 24-, and 40-hr culture periods.

As a rule the experiments *in vitro* were duplicated or triplicated. Incubations were done in duplicate in each experiment; results are expressed as means of two incubations of a typical experiment.

Statistics

The data were analyzed for significance of differences by Student's *t*-test (De Jonge, 1960).

RESULTS

Oral Route

Rats. In Table 1, body and relative organ weights of animals fed compounds of the large series tested that affected lymphoid organs are presented. Mortality occurred in the 150-ppm of DHLA group (one female) and in the 150-ppm of DBTC group (four

[10] Obtained from Schwarz/Mann, Orangeburg, New York.
[11] Obtained from Falcon Plastics, Oxnard, California.
[12] Obtained from Merck A.G., Darmstadt, Germany.
[13] Coulter Counter, Model ZF, Coulter Electronics, Dunstable, Bedfordshire, England.

females and two males) in the second week. The relative weights of lymphoid organs (thymus, spleen, and popliteal lymph nodes) were decreased in a dose-related manner in DOTC-, DETC-, DPTC-, and DBTC-fed animals. The decrease in thymus weight was most pronounced. The relationship between the length of the alkyl chain and the reduction of thymus weight is presented in Fig. 1. DBTC and DOTC, the most active compounds, and also DPTC caused a significant decrease in thymus weight at both feeding levels in males as well as in females. DETC caused a significant reduction of thymus at the highest dose only. In the case of the less active compounds, the effect on the thymus occurred at doses that induced decreased weight gain or decreased liver weights.

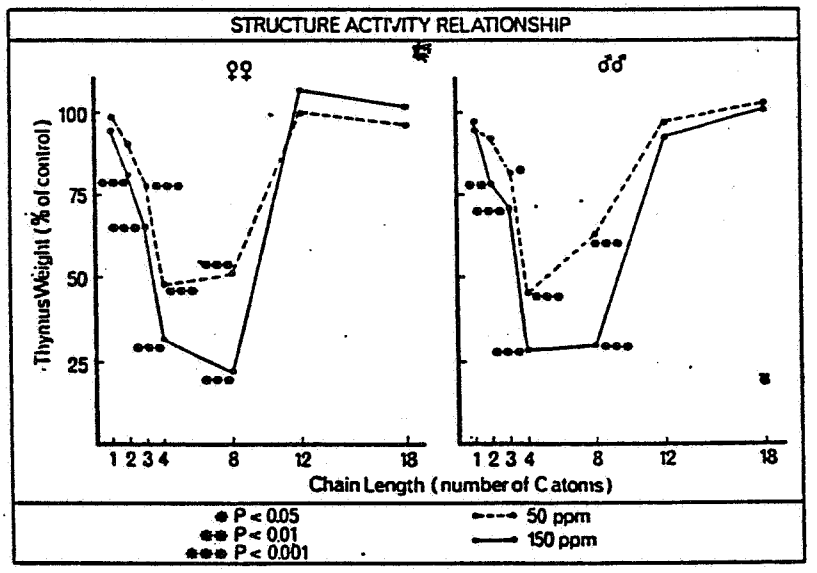

FIG. 1. Relationship between length of the alkyl chain of dialkyltin compounds and its effect on thymus weight determined in groups of 10 male and 10 female rats fed various dialkyltin compounds at 0, 50, or 150 ppm for 2 weeks.

At necropsy, a pronounced reduction in size of the thymus was found in all animals fed DBTC and DOTC and in animals fed the highest dose of DPTC. Thickened and dilated bile ducts accompanied by irregularly yellowish discolored livers were found in the animals that died and in two male and two female survivors fed 150 ppm of DBTC. In two males and two females that died in this group, abdominal edema was observed. One female that died at 150 ppm of DHLA was emaciated but did not show gross organ changes.

Microscopically, severe proliferation of bile duct epithelial cells and bile ductules, associated with pericholangiolitis and periportal fibrosis, was found in livers of four male and six female rats fed 150 ppm of DBTC. Slight bile ductule proliferation also occurred in two males at 150 ppm of DHLA, whereas at 50 ppm of DBTC and DHLA no liver changes were seen.

The most prominent effect found was lymphocyte depletion in lymphoid organs, and it was most pronounced in the thymic cortex of animals fed DOTC and DBTC. At the 150-ppm level, the cortex was almost completely depleted. Signs of cell destruction, such as karyorrhexis or "starry sky" formation was never observed. Also, lymphocyte

TABLE 1

BODY AND RELATIVE ORGAN WEIGHTS OF RATS FED VARIOUS ORGANOMETAL COMPOUNDS AT LEVELS OF 0, 50, OR 150 PPM FOR 2 WEEKS[a]

Dietary level (ppm)	Compound and sex	Body weight (g)	Relative organ weights (per body weight)			
			Liver (g/kg)	Thymus (g/kg)	Spleen (g/kg)	Popliteal lymph nodes (mg/kg)
0	DETC F	96.8 ± 2.0	44.8 ± 0.7	4.07 ± 0.15	3.75 ± 0.20	75 ± 10
50		94.1 ± 1.3[b]	44.2 ± 0.5	3.68 ± 0.29[b]	3.66 ± 0.19	69 ± 6
150		88.9 ± 1.5[c]	45.3 ± 1.2	3.28 ± 0.13[c]	3.29 ± 0.24[c]	61 ± 4[c]
0	DETC M	118.2 ± 1.9	54.5 ± 1.3	3.52 ± 0.21	3.07 ± 0.09	63 ± 6
50		105.7 ± 2.7[c]	52.2 ± 0.8[c]	3.22 ± 0.15[b]	3.22 ± 0.15[d]	58 ± 6
150		99.9 ± 2.6[c]	52.1 ± 0.9[c]	2.73 ± 0.13[c]	2.70 ± 0.13[c]	48 ± 2[c]
0	DPTC F	96.8 ± 2.0	44.8 ± 0.7	4.07 ± 0.15	3.75 ± 0.20	75 ± 10
50		97.6 ± 2.9	46.8 ± 1.7[b]	3.19 ± 0.20[c]	3.67 ± 0.18	75 ± 7
150		96.5 ± 2.4	45.2 ± 1.1	2.64 ± 0.13[c]	3.37 ± 0.20[c]	64 ± 6[b]
0	DPTC M	118.2 ± 1.9	52.5 ± 1.3	3.52 ± 0.21	3.07 ± 0.09	63 ± 6
50		116.0 ± 3.3	53.6 ± 1.3	2.85 ± 0.15[c]	3.01 ± 0.12	63 ± 5
150		106.1 ± 2.3[c]	51.9 ± 1.2	2.49 ± 0.13[c]	2.76 ± 0.05[c]	46 ± 6[c]

0	DBTC	106.4 ± 2.3	49.7 ± 0.9	3.76 ± 0.15	3.20 ± 0.12	62 ± 4
50	F	102.2 ± 0.9[c]	49.3 ± 1.3	1.79 ± 0.10[c]	2.39 ± 0.12[c]	50 ± 3[c]
150		86.0 ± 7.0[c]	50.8 ± 2.3	1.20 ± 0.18[c]	2.18 ± 0.08[c]	52 ± 6[c]
0	DBTC	115.3 ± 3.9	42.5 ± 0.9	3.77 ± 0.19	3.62 ± 0.20	73 ± 10
50	M	107.7 ± 2.4[c]	42.9 ± 0.7	1.70 ± 0.11[c]	3.01 ± 0.13[c]	57 ± 3[c]
150		92.1 ± 4.5[c]	49.3 ± 1.0[c]	1.04 ± 0.12[c]	2.41 ± 0.11[c]	52 ± 6[c]
0	DOTC	96.5 ± 2.1	45.4 ± 1.0	3.97 ± 0.21	2.85 ± 0.11	83 ± 6
50	F	95.1 ± 2.9	46.7 ± 1.0	2.02 ± 0.26[c]	2.78 ± 0.17	66 ± 5[c]
150		85.0 ± 1.8[c]	43.3 ± 1.5[b]	0.83 ± 0.06[c]	2.59 ± 0.14[c]	58 ± 6[c]
0	DOTC	109.2 ± 1.8	51.6 ± 0.6	3.72 ± 0.22	3.41 ± 0.25	92 ± 9
50	M	109.9 ± 3.4	51.8 ± 0.7	2.34 ± 0.21[c]	2.98 ± 0.12[c]	75 ± 6[c]
150		103.9 ± 5.1[b]	50.0 ± 0.9[c]	1.07 ± 0.10[c]	2.67 ± 0.15[c]	74 ± 7[c]
0	DHLA	100.3 ± 2.0	47.8 ± 0.7	3.59 ± 0.13	3.68 ± 0.17	68 ± 7
50	F	102.1 ± 1.3	51.3 ± 1.5[c]	3.69 ± 0.15	4.11 ± 0.23[c]	76 ± 7[d]
150		77.1 ± 5.1[c]	50.8 ± 0.7[c]	3.27 ± 0.36[d]	3.38 ± 0.26[b]	49 ± 9[c]
0	DHLA	117.2 ± 1.9	53.7 ± 0.9	3.65 ± 0.19	4.63 ± 0.34	75 ± 8
50	M	113.5 ± 2.8[b]	53.5 ± 0.7	3.51 ± 0.21	3.86 ± 0.21[c]	71 ± 7
150		75.2 ± 6.5[c]	55.8 ± 2.7[d]	2.80 ± 0.32[c]	3.49 ± 0.16[c]	50 ± 6[c]

[a] Mean values ± SD; 10 animals per group.
[b] $p < 0.01$.
[c] $p < 0.001$.
[d] $p < 0.05$.

depletion was present in the thymus-dependent areas of the spleen and popliteal lymph node (respectively, periarteriolar lymphocyte sheets and paracortical areas).

Other treatment-related histopathological changes were not noted.

Other animal species. Growth of guinea pigs on the DOTC diet showed a dose-related decrease (Table 2). At the 100-ppm level, growth was severely inhibited. One guinea pig of the highest dose group died during Week 3, and the remaining animals were in very poor condition. The general appearance of mice fed DBTC and quail fed DOTC did not differ from that of the controls; body weights were the same in the various groups.

TABLE 2

BODY AND RELATIVE ORGAN WEIGHTS OF MALE MICE, GUINEA PIGS, AND JAPANESE QUAIL FED DIETS CONTAINING VARIOUS AMOUNTS OF DBTC OR DOTC FOR 4 WEEKS[a]

Compound dietary level (ppm)	Body weight (g)	Relative organ weights (g of organ/100 g body weight)			
		Thymus	Spleen	Bursa of Fabricius	Liver
		Mouse			
DBTC					
0	26.7 ± 2.1	0.327 ± 0.039	0.367 ± 0.044	—	5.65 ± 0.07
50	25.7 ± 1.4	0.300 ± 0.050	0.351 ± 0.042	—	5.49 ± 0.24
150	25.9 ± 2.0	0.342 ± 0.068	0.422 ± 0.068	—	5.34 ± 0.54
		Guinea pig			
DOTC					
0	454 ± 34	0.130 ± 0.026	0.139 ± 0.032	—	3.40 ± 0.79
50	396 ± 41[b]	0.124 ± 0.020	0.142 ± 0.026	—	3.74 ± 0.33
100	258 ± 33[c]	0.081 ± 0.037[b]	0.130 ± 0.035	—	3.38 ± 0.58
		Japanese quail			
DOTC					
0	131 ± 7	0.302 ± 0.058	0.462 ± 0.015	0.183 ± 0.054	2.63 ± 0.21
300	129 ± 10	0.256 ± 0.081	0.411 ± 0.011[c]	0.195 ± 0.041	2.70 ± 0.51
600	125 ± 4	0.350 ± 0.141	0.468 ± 0.010	0.130 ± 0.051	2.49 ± 0.20

[a] Mean values ± SD; 6–10 animals per group.
[b] $p < 0.05$.
[c] $p < 0.001$.

In contrast to rats, weights of lymphoid organ were not affected by DBTC and DOTC in mice and quail, respectively. In guinea pigs, however, thymus weight was significantly decreased at the 100-ppm DOTC level and was associated with a strongly decreased body weight. In addition, the relative adrenal weights of these animals were markedly increased from 0.41 ± 0.09 mg/g body weight in the control group to 0.61 ± 0.06 mg/g in the 100-ppm group ($p < 0.001$). The weights of the liver and kidney did not differ between the test and control groups.

At pathological examination, the guinea pigs fed 100 ppm of DOTC appeared to be emaciated. Two animals showed abdominal edema. The content of the gastrointestinal tract contained fluid. A reduction in size of the thymus was found in six guinea pigs at 100 ppm of DOTC. Histologically, there was marked depletion of lymphocytes in the

thymic cortex. At variance with rats, in the cortex "starry sky" appearance was noted; i.e., phagocytosis of pycnotic lymphocytes by macrophages. Also, the Hassal corpuscles were conspicuous.

Rats: Recovery experiment. Body weights of DOTC-treated animals were significantly reduced up to 2 weeks after treatment (Fig. 2) and remained lower than the controls

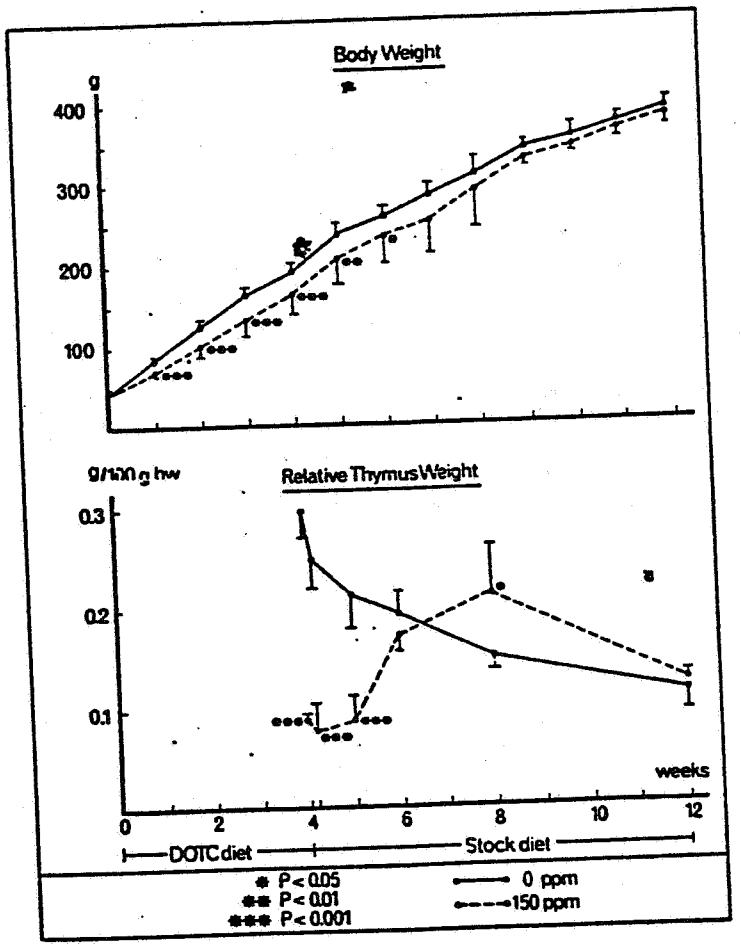

FIG. 2. Reversibility of DOTC-induced growth retardation and thymus weight reduction in rats kept on a 150-ppm of DOTC diet for 4 weeks and after that period on a stock diet for 8 weeks. (means ± SD of five or more animals per group).

during the whole period. During Week 3, three animals of the DOTC group died. They showed thickened and dilated bile ducts and abdominal edema.

The severe reduction of thymus weight (78%) induced by 150 ppm of DOTC for 4 weeks was followed by fast recovery (Fig. 2). After 2 weeks feeding of the stock diet, thymus weights of DOTC-treated animals did not differ significantly from the controls. After 4 weeks, thymus weights of treated animals were higher than the controls. This is considered to be a compensatory reaction as is seen in many healing processes. Eight weeks after treatment thymus weights were the same as the controls.

Intravenous Route

Rats. The effects of repeated injections of DMTC, DETC, DBTC, and DOTC on body and thymus weights are shown in Fig. 3. From these data, it can be concluded that both DBTC and DOTC have a strong effect on thymus weight, as was shown in the feeding experiment. Thymus atrophy was present at doses of 1 and 2 mg/kg, which did not affect growth or liver and kidney weights. At the 4-mg/kg dose, thymus weight was severely depressed. However, at this dose other toxic effects were noted: growth retardation, increased liver weight (DBTC), and increased kidney weight (DOTC). In

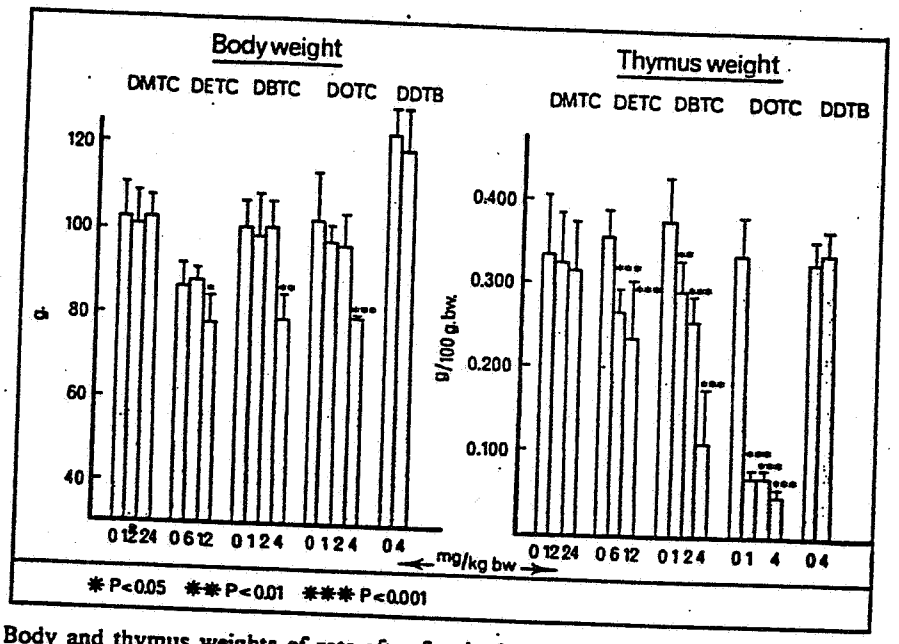

FIG. 3. Body and thymus weights of rats after five iv doses of various organotin compounds (means ±SD of six to eight animals per group).

contrast, DMTC did not affect the thymus; even at the highest dose no effect was seen on thymus weight or on other organ weights. However, after a single injection of 48 mg/kg, three of the eight animals died within 2 days. DETC slightly depressed thymus weight, at doses that also decreased growth rate and increased liver weights. Doses of 1, 2, and 4 mg/kg did not affect lymphoid organ weights. DDTB was not toxic at 4 mg/kg, which was the highest dose tested because of low solubility in the vehicle. The weights of spleen and adrenals were not affected by any of the compounds tested.

At microscopic examination, thymus atrophy, associated with lymphocyte depletion, was observed in animals repeatedly dosed with 1, 2, or 4 mg/kg of DOTC and DBTC and with 6 and 12 mg/kg of DETC. As in the oral treatment studies, iv administration of DMTC and DDTB did not affect lymphoid organs. No liver or bile duct changes were found, as occurred in animals fed 150 ppm of DBTC. Other treatment-related histopathological changes were not noted.

Effects of a single injection of DOTC on body weight, thymus weight, cell number, and cell viability are given in Table 3. A dose-related reduction of thymus weight, cell number, and cell viability was present in all treatment groups (1, 2, 4, and 8 mg/kg).

TABLE 3

BODY WEIGHT, THYMUS WEIGHT, CELL COUNT, AND CELL VIABILITY OF RATS KILLED 4 DAYS AFTER A SINGLE INTRAVENOUS INJECTION OF DOTC[a]

Dose (mg/kg)	Body weight (g)	Thymus		
		Weight (mg)	Cell count ($\times 10^6$)	Cell viability (%)
0	65.4 ± 3.9	233 ± 40	349 ± 58	79 ± 5
1	66.4 ± 4.7	174 ± 34[b]	216 ± 86[c]	75 ± 7
2	61.6 ± 4.9	105 ± 25[d]	112 ± 48[d]	65 ± 9[b]
0	67.5 ± 3.1	239 ± 24	364 ± 59	74 ± 8
4	63.8 ± 2.5	102 ± 19[d]	111 ± 31[d]	56 ± 16
8	51.0 ± 3.0[d]	55 ± 10[d]	30 ± 15[d]	46 ± 14[c]

[a] Mean value ± SD; five animals per group.
[b] $p < 0.05$.
[c] $p < 0.01$.
[d] $p < 0.001$.

Only at the highest dose level was body weight reduced; thymus weight was 24% of the control value, whereas cell number was only 7% of that of the controls.

In Vitro Experiments

The total number and viability of rat thymocytes were decreased in a dose-related fashion in the presence of DBTC (Fig. 4). At the lowest concentration tested (0.05 μg of DBTC/ml), the cell count was still largely decreased. The thymocyte count diminished progressively to 31% and thymocyte viability to 61% of the control value after 24 hr of incubation with 50 μg of DBTC/ml.

Human thymocytes, cultured with 0.5, 5, or 50 μg/ml of DBTC, formed aggregates (probably due to agglutination) which could not be resuspended on a whorl mixer. Thus, thymocyte number was decreased in relation to dose, while cell viability was not affected by DBTC. Viability of cell aggregates could not be precisely determined but was not significantly diminished.

In contrast to those of humans and rats, no effect was found on cell count and viability of mouse and guinea pig thymocytes cultured in the presence of DBTC concentrations up to 50 μg/ml (Fig. 4). This different response to DBTC was found when media supplemented with species-specific serum was used. This species difference also occurred when rat, guinea pig, and human thymocytes were cultured under the same conditions with heterolog serum. Thus, cell survival was the same in cultures with isologous, homologous, or heterologous serum.

When the effect of different dialkyltindichlorides in rat thymocyte cultures were compared (Fig. 5), only DOTC and DBTC decreased cell count and viability at concentrations of 0.012 and 0.12 mM, whereas no distinct effect was noted with DMTC and DETC.

In contrast to the effect on rat thymocytes, DBTC and DOTC did not reduce rat bone marrow cell survival under the same culture conditions (Fig. 6). Number and viability of rat bone marrow cells were the same when cultured with 0, 5, or 50 μg of DBTC or DOTC/ml for periods up to 40 hr.

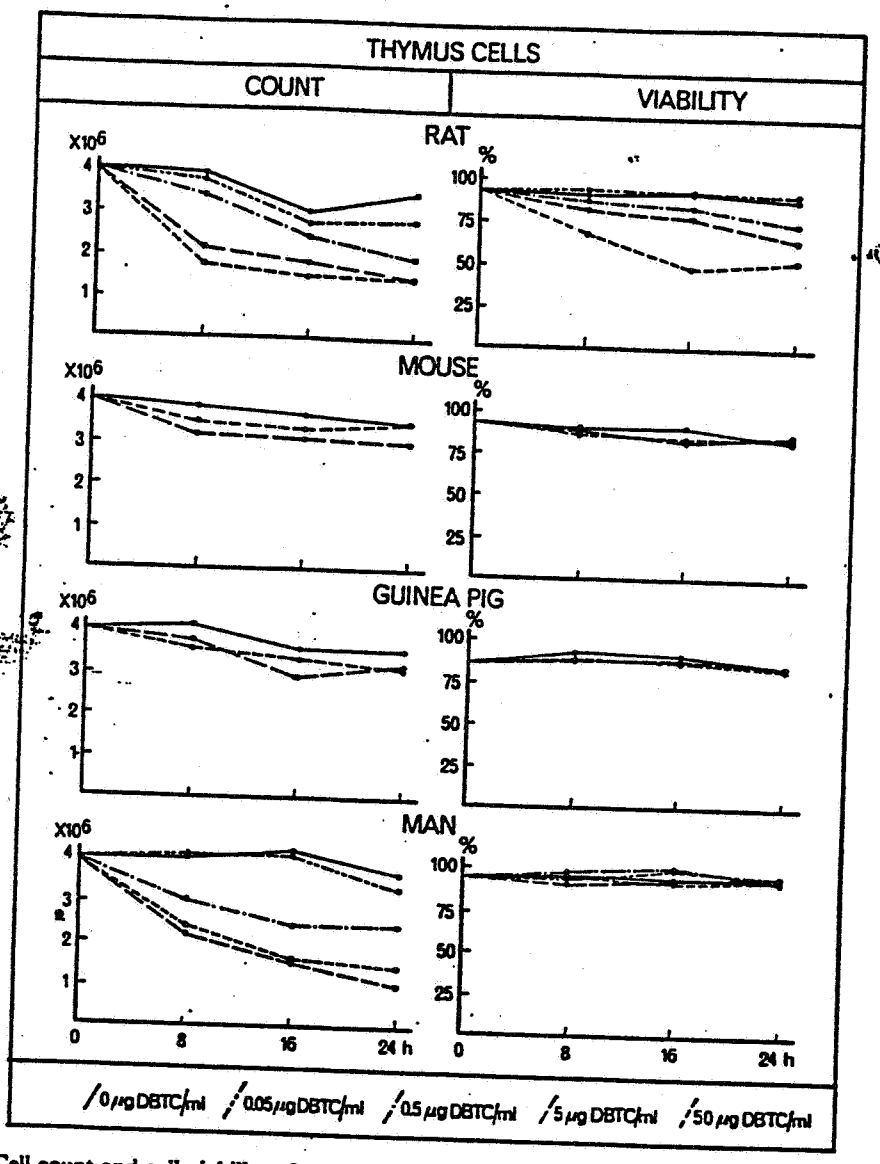

FIG. 4. Cell count and cell viability of rat, mouse, guinea pig, and human thymocytes incubated for 0, 8, 16, or 24 hr with 0, 0.05, 0.5, 5, or 50 μg of DBTC/ml of medium. Results are means of two incubations.

DISCUSSION

From the present study it appears that DBTC and DOTC and, to a lesser degree DETC and DPTC, induce reduction of thymus weight of rats at dietary levels of 50 and 150 ppm. If thymus weight was markedly reduced, the weights of peripheral lymphoid organs (popliteal lymph nodes and spleen) were also decreased, which was especially the case with the popliteal lymph node. The spleen was least effected, which can be readily explained by the mixed function of this organ. MOTC, TOTC, and TOT did not affect thymus weight.

Feeding of 50 or 150 ppm of DBTC to mice and 300 or 600 ppm of DOTC to Japanese quail for 4 weeks did not cause atrophy of lymphoid organs. Feeding 100 ppm

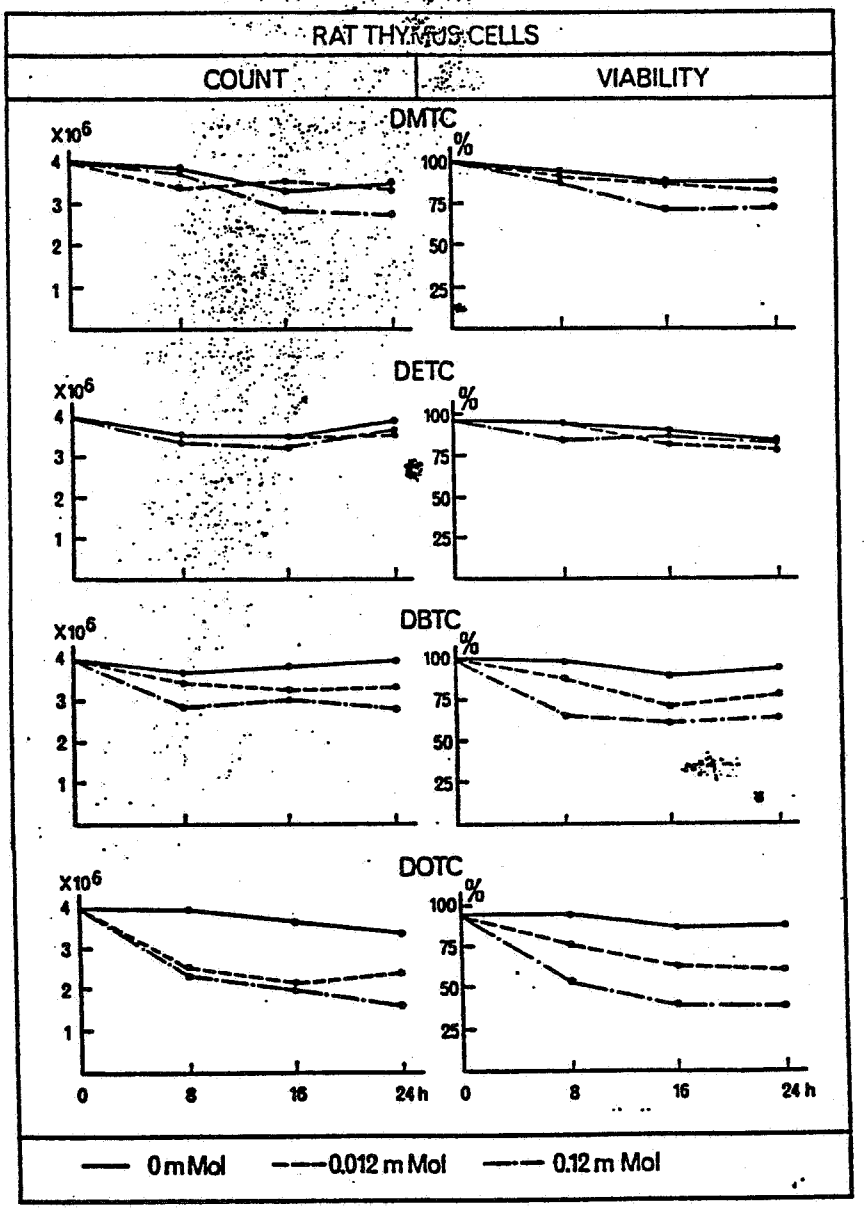

FIG. 5. Cell count and cell viability of rat thymocytes incubated with 0, 0.012, or 0.12 mM DMTC, DETC, and DOTC for 0, 8, 16, or 24 hr. Results are means of two incubations.

of DOTC to guinea pigs resulted in a significant decrease in thymus weight. At the same dose, however, adrenal weights were increased, and in the cortex of the thymus, "starry sky" appearance was present, indicating that the thymus atrophy in this instance is indirectly caused by stress (increased release of glucocorticoids). In a previous study, it was shown that such atrophy in rats was not related to stress, since the same effect was seen in adrenalectomized animals, but to a cytotoxic action *in vivo* on lymphocytes but not on bone marrow cells (Seinen and Willems, 1976).

After repeated intravenous administration, DBTC and DOTC caused thymus atrophy at doses of 1 and 2 mg/kg, which did not affect growth or kidney or liver

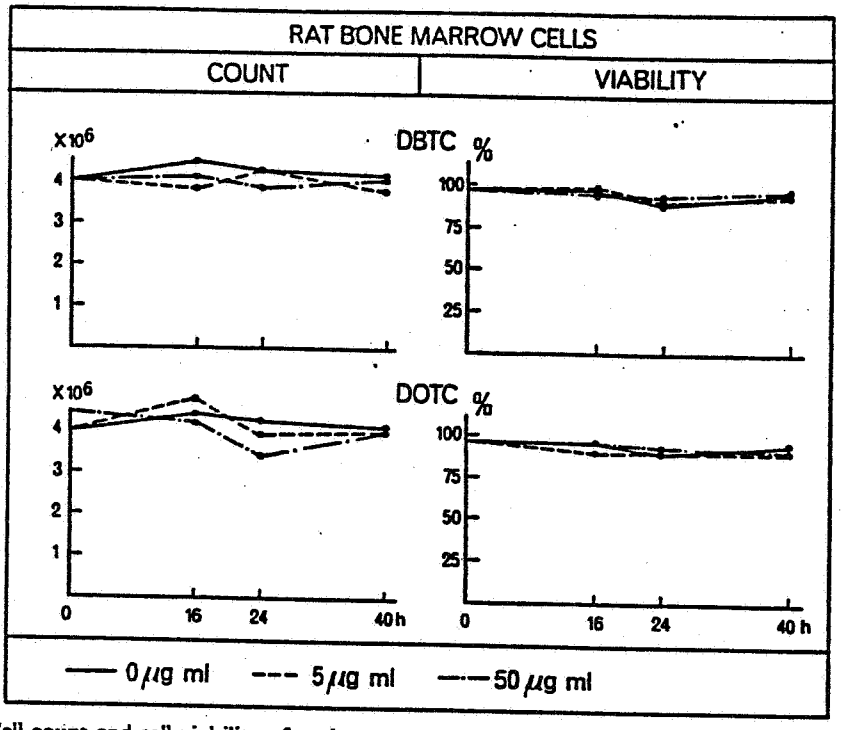

FIG. 6. Cell count and cell viability of rat bone marrow cells incubated for 0, 16, 24, or 40 hr with 0, 5, or 50 μg of DBTC and DOTC/ml of medium. Results are means of two incubations.

weight. Even a single injection of 1 mg/kg or more, DBTC (unpublished results) or DOTC caused marked atrophy of the thymus. After a single injection of 8 mg/kg of DOTC, thymus weight was 24% of the control value, whereas thymocyte number was only 7% of the control value. Perhaps this selective effect on the thymus is related to a relatively high concentration in this organ as was shown by Seidler *et al.* (1971) after a single oral intubation of [^{14}C] DOTC in rats.

Although DBTC- and DOTC-induced effects on the thymus were so severe that they represent a "chemical thymectomy," the effects were completely reversible (Fig. 2). These recovery data are comparable with those of McAnulty and Dickerson (1973) after "nutritional thymectomy." By restriction of food intake in weanling rats for 28 days, they induced a thymus weight reduction of 81%. But on rehabilitation the thymus weight returned to control values within 16 days. The similarity of the recovery of the thymus after DOTC feeding and nutritional deprivation suggests that the half-life of DOTC is possibly short, but no data are available.

The extent of dialkyltin-induced thymus atrophy was strongly related to the chain length of the alkyl group (Fig. 1) and is probably related to the water–lipid distribution of the homologs. This structure–activity relationship regarding atrophy of the thymus mimics that observed by Kaars Sijpesteijn (1969) for the antibacterial activity of dialkyltinchlorides, with the exception of DOTC, a compound that did not show an antibacterial activity. In contrast, dialkyl lead compounds which were approximately 10 times more active against bacteria than dialkyltin compounds (Kaars Sijpesteijn, 1969) had no distinct effect on the thymus. Thus it seems likely that the mechanism of "anti-thymus" and antibacterial activity is different.

DBTC was the most toxic of the organotin compounds tested. It caused mortality in six out of 20 weanling rats at a dietary level of 150 ppm. In these animals severe liver and biliary changes and abdominal edema were observed, as described before by Barnes and Magee (1958). At variance with Barnes and Stoner (1958), we did not find bile duct damage at the 50-ppm level. Gaunt *et al.* (1968) noted only a slight hypochromic anemia in rats receiving 80 ppm of DBTC in their diet for 90 days. Thus, they established a dietary no-effect level of 40 ppm of DBTC. Probably Gaunt *et al.* (1968) overlooked the thymus effect of DBTC. In a 2-week study in rats we found that thymus weight was reduced by 20 ppm of DBTC as well as by 20 ppm of DOTC. Therefore, the no-effect level in a 90-day study will be probably much lower than that established by Gaunt *et al.* (1968).

In the present *in vitro* studies a cytotoxic effect of both DBTC and DOTC was demonstrated in suspension cultures of rat thymocytes. Thymocyte survival decreased in direct proportion to the DBTC concentration in the nutrient medium. The number of rat thymocytes was decreased after incubation with a concentration as low as 0.05 μg of DBTC/ml of medium for 24 hr. After 24 hr at 50 μg of DBTC/ml only 20% of the thymocytes survived. However, survival of rat bone marrow cells was not affected, when cultured with concentrations of DBTC and DOTC up to 50 μg/ml for 40 hr under the same conditions. In contrast, marked differences in sensitivity to DBTC and DOTC were found between cultures of thymocytes of different species. Cell number and viability were not affected by DBTC in cultures of mouse and guinea pig thymocytes. The results of the studies with thymocytes *in vitro*, both on structure–activity relations and species sensitivity, are in full agreement with the *in vivo* results.

The effect *in vitro* of DBTC on human thymocytes differed from that observed with lymphocytes from rats. Human thymocytes cultured with 0.5, 5, or 50 μg of DBTC/ml agglutinated, resulting in a dose-related decrease of thymocyte number with unaffected viability. Agglutination can be considered a toxic effect, since human thymocytes did not incorporate tritium-labelled thymidine after mitogenic stimulation with PHA and Con A in cultures with even lower levels of DBTC (unpublished observations).

Since the effect of DBTC in cell cultures was essentially the same with isolog, homolog, or heterolog serum in the nutrient medium, the differences found between the species are a direct consequence of a difference in cytotoxicity and not due to differences in protein binding of DBTC.

Cytotoxic effects of organotin stabilizers have been indicated first by Guess and Stetson (1968). In monolayer cultures of mouse fibroblasts and chick embryo cells, Guess and Haberman (1968) proved the cytotoxicity of many commercially used dibutyltin derivatives and one dioctyltin stabilizer. Also Conning and Firth (1969), Pelling *et al.* (1973) and Grasso *et al.* (1973) showed cytotoxic effects of dibutyltindiacetate-stabilized plastics in monolayer cultures of various cell types. The previous authors all found a comparable *in vitro* sensitivity of various cell types to the dibutyltin or dioctyltin derivatives either used as such or after extraction of PVC. However, one can question the significance of these *in vitro* results for the *in vivo* situation. In our *in vivo* studies with rats it was shown both by oral and iv administration that the thymus is the target organ and thymocytes the target cells of DBTC and DOTC toxicity. Therefore, the quoted cytotoxicity of the organotin stabilizers for other cell types may have relevance for the topical use of organotin-stabilized PVC; e.g., in medical devices,

when relatively high concentrations can be expected locally, but not for the systemic toxicity of the organotin compounds.

From this study we conclude that DBTC and DOTC are selectively cytotoxic for thymocytes of rats. Possibly these compounds act in the same manner in man. Since the thymus plays a central role in immunity, in further studies the significance of DBTC- and DOTC-induced lymphoid atrophy regarding function of the immune system will be assessed.

ACKNOWLEDGMENTS

The authors thank Dr. E. J. Bulten, Institute for Organic Chemistry, TNO, Utrecht, for the supply of organometal samples.

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O

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT O

1998 Testing Results, Anresco Incorporated

ANRESCO

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ANALYSIS RESEARCH CONSULTING

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Tel: (954) 486-2233
Fax: (954) 486-2886

8 June 1998

Thomas Reid Associates
560 Waverley St.#201 Box 880
Palo Alto, CA 94301

FILE NO.498324

Attn: Pat Kobernus - 650-327-4024

Re: CPVC Pipe - Leachables Project
1 - preparation of CPVC pipe turnings/shaving for Dioxins testing
2 - extraction of same with deionized water - forward to lab
3 - extraction of same with chlorinated water - forward to lab
4 - purchase & forward sealed CPVC cement & primer cans to lab
Items 2 & 3 for organotin & other organics analyses

Received 4/09/98

Final Report:

Narrative

We have now completed all the assigned tasks and forwarded our samples to the appropriate laboratories. The one final glitch was the timing on the chlorinated conditioning water extractions which were originally scheduled to end 5/22 but due to problems with the rotator were not completed and ready for shipment to West Coast Lab until 6/8.
I have attached copies of the letters sent to each lab with the samples, receipts for the CPVC pipe & cement/primer; as well as spreadsheets with the extraction monitoring data.
We have followed meticulously the protocols you required or were proposed by us & approved by you for each step in this process. Please feel free to contact me with any questions.

Reported by:
ANRESCO, INC.

E. Jerry Oliveras
Laboratory Director

01

5/1/98 498324

CPVC pipe markings for TRA project

The following is printed in black and repeats after a gap along the length of pipe - no other markings:

½" CTS Genova CPVC 4120
Hi Temp 100 PSI @ 180°F
- 690 KPa @ 82°C
Potable [ASTM D 2846] NSF-DW (SA)
B 137.6 SDR-11 Hot-N-Cold
50005 31095 M 103N - 258814-
→ a "barcode" appears ←

C 385615 0005 9 Made in USA

ANRESCO, Inc.

E. Jerry Oliveras

02

ORCHARD SUPPLY HARDW
1025 ASHBY AVENUE
BERKELEY
CA 947100000
(510) 540-6638

NORMAL SALE

029664019319 S.CUSHION-DK GREEN	1@	9.99	9.99 T
*091444711508 FATAP 6X1-1/2 SCRE	1@	3.05	3.05 T
043168970051 90W HALOGEN PAR 38	1@	9.99	9.99 T
038753318202 CPVC CEMENT LO-VOC	1@	2.59	2.59 T
038753319001 PVC PRIMER LO-VOC	1@	1.99	1.99 T
SUBTOTAL			27.61
TAX @ 8.250%			2.28
TOTAL			29.89
CASH			30.00
CHANGE			0.11-

NOW OPEN
MONDAY TO
FRIDAY AT
7 AM

** 470 02 120 4448 05/20/98 19:48:56

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NORMAL SALE

038753318219 LO-VOC CEMENT 3182	1@	3.99	3.99 T
036296130114 1/4" TOGGLER BOLT	1@	2.39	2.39 T
*045325140048 DRILL BIT-MASONRY	1@	1.79	1.79 T
033656379008 SILVER CLOTH DUCT	1@	8.99	8.99 T
7754849 CPVC TUBING *PULLTAG*	6@	3.49	20.94 T
043374055870 36" DOOR SWEEP-ADH	1@	3.09	3.09 T
043374115857 36" ALUM. THRESHOL	1@	22.99	22.99 T
718106104767 DOORMAT	1@	7.99	7.99 T
718106104767 DOORMAT	1@	7.99	7.99 T
718106104767 DOORMAT	1@	7.99	7.99 T
SUBTOTAL			88.15
TAX @ 8.250%			7.27
TOTAL			95.42
VISA NO: 4417128418201123			95.42
AUTH NO: 020268			
CHANGE			0.00

CHARGE DRAFT

ACCOUNT # 4417128418201123

AUTH # 020268

HARDWARE/GARDEN MERCH	95.42
TOTAL CHARGE VISA	95.42

-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*

CUSTOMER'S SIGNATURE

I AGREE TO PAY THE ABOVE TOTAL
AMOUNT ACCORDING TO THE CARD
ISSUER AGREEMENT.

X_____

THANK YOU FOR CHOOSING ORCHARD

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11 May 1998

Thomas Reid Associates
560 Waverley Street, Suite 201 - P.O. Box 880
Palo Alto, CA 94301
Atn: Thomas Reid Phone: 650-327-0429 FAX: 650-327-4024

Re: CPVC Pipe turnings/shavings leaching project, update

Dear Tom:

Per our phone conversations of last week and the FAX of last Thursday afternoon ANRESCO will perform the following:

1) Prepare CPVC pipe turnings (each 10' pipe produces about 300g turnings) using the protocol you provided for the Dioxins portion of this project.

2) **Duplicate** ca. 20 gram portion of the turnings will be extracted with ca. 1 liter of deionized water at room temperature for 5 days. The extraction will be agitated using the tumbler apparatus described in the EPTOX method; i.e. 30rpm continuous rotation). The extraction jars will have no headspace. Exact time, temperature(high/low), **pH(daily)**, weights and volumes will be recorded. Both extracts produced will be decanted/filtered (Whatman GFA glass microfiber filter) to clean containers and shipped to West Coast Analytical Service, Inc.; one for analysis of organo-tin compounds the other for VOA/clorinated organics analysis .

3) Another **duplicate set** of test portions will be prepared & analysed as above but using pH 8 conditioning water (prepared as specified on page B63-65 of ANSI/NSF 61 - 1997b Appendix B "Extraction Water Preparation", which you provided, will be used as the extraction fluid. A chlorine residual of 2mg/L will be maintained (reagent grade sodium hypochlorite). All other conditions will remain as noted above. The amount of chlorine demand will be recorded. Monitoring & adjustments to chlorine residual level will be made daily.

4) A set of duplicate blank extracts (reagents only) of 1 & 2 will be prepared & treated identically to the sample extracts as noted above. These will be forwarded to the lab as negative controls.

5) One separate portion of the turnings will be prepared as 1&2 above but with 2 mcg of plictran (tricyclohexyl tin hydroxide, a.k.a. cyhexatin) added with the sample prior to extraction. The two extracts produced will be sent to the lab as positive controls for the organo-tin analysis.

Please contact me ASAP if you again wish to modify this protocol. We will begin the first set of six extractions Tuesday morning. These extracts will then be ready for shipment to the Lab on Monday 5/18. The second set of four extractions would then commence Sunday 5/17 and be ready for shipment on Friday 5/22.

Best Regards:

E. Jerry Oliveras
Laboratory Director

F:\users\jerry\tra598.wpd

04

ANRESCO

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Thomas Reid Associates
560 Waverley Street, Suite 201 - P.O. Box 880
Palo Alto, CA 94301
Atn: Thomas Reid Phone: 650-327-0429 FAX: 650-327-4024

5 May 1998

setup extracts in dup use dup for voa & chlorinated org testing

Re: CPVC Pipe turnings/shavings leaching project

Dear Tom:

Per our phone conversation of last week ANRESCO will perform the following:

1) Prepare CPVC pipe turnings (each 10' pipe produces about 300g turnings) using the protocol you provided for the Dioxins portion of this project (The sample should have arrived at Quanterra on Monday, 5/4).

2) A ca. 20 gram portion of the turnings will be extracted with ca. 1 liter of deionized water at room temperature for 5 days. The extraction will be agitated using the tumbler apparatus described in the EPTOX method; i.e. 30rpm continuous rotation). The extraction jars will have no headspace. Exact time, temperature, weights and volumes will be recorded. The extract produced will be decanted to a clean container and shipped to West Coast Analytical Service, Inc. for analysis of organo-tin compounds.

3) Another test portion will be prepared as above but using deionized water in which a 5mg/L chlorine residual will be maintained (household bleach {sodium hypochlorite} will be used to achieve this) as the extraction fluid. All other conditions will remain as noted above. The amount of chlorine demand will be recorded. Adjustments to chlorine residual level will be made twice daily if required (morning & evening).

pH > 4

4) A blank extract (reagents only) of each will be prepared & treated identically to the sample extracts as noted above. These will be forwarded to the lab as negative controls.

5) Separate portions of the turnings will be prepared as 1&2 above but with 2 mcg of plictran (tricyclohexyl tin hydroxide, a.k.a. cyhexatin) added with the sample prior to extraction. The extracts produced will be sent to the lab as positive controls.

Please contact me ASAP if you wish to modify this protocol. We will begin the extractions Wednesday morning. The extracts will then be ready for shipment to the Lab on Monday 5/11. I am sorry we were so delayed in getting to the Dioxins project. It won't happen again. (P.S. I produced all the turnings myself on Friday afternoon.)

Best Regards;

Monitor pH on all extractions
adjust ? with what ?

E. Jerry Oliveras
Laboratory Director

F:\users\jerry\tra598.wpd

05

ANRESCO

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Fax: (954) 486-2886

8 June 1998

File Number: 498324-Cl-#1thru#5

West Coast Analytical Service, Inc.
9840 Alburtis Avenue
Santa Fe Springs, CA 96070
Atn: Eric Lindsay

Re: Analysis for organo-tins & drinking water organics for Thomas Reid Associates
Chlorinated (pH 8 conditioning*) water extractions

Dear Mr. Lindsay:

Please find enclosed five amber glass jars (ca. 1L each) of conditioning water extracts and controls for the Thomas Reid Associates project. Hopefully Mr. Reid has already alerted you to expect these samples and has discussed the required analyses. These samples should be reported directly to Mr. Thomas Reid and not ANRESCO. All billing for this project should go directly to Thomas Reid Associates, not ANRESCO. IF you need clarification, etc. please feel free to contact me at your convenience.

Client Contact: Mr. Thomas Reid (e-mail tra@igc.org)
Thomas Reid Associates
560 Waverly Street, Suite 201 - PO Box 880
Palo Alto, CA 94301 Phone: 650-327-0429 FAX 650-327-4024

Samples being submitted:
498324-Cl-#1 water extract for organo-tin analysis {20.77g CPVC in 968mL) - pH 8.58
498324-Cl-#2 water extract for organotin analysis spiked with 2.4 microgram Plictran - pH 8.79
(tricyclohexyl tin hydroxide, cyhexatin) {20.58g CPVC in 971mL)
498324-Cl-#3 conditioning water blank for organo-tin analysis - pH 8.96
498324-Cl-#4 water extract for organic compounds analysis{22.13g CPVC in 967mL} - pH 9.26
498324-Cl-#5 conditioning water blank for organic compounds analysis - 9.21

Spike was produced using 5 microliters of a solution of 9.6mg Plictran in 20mL acetone.

Best Regards;

E. Jerry Oliveras
Laboratory Director

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*** conditioning water described in attached pages, section 13.5**

06

ANRESCO, Inc.
18 May 1998
File Number: 498324-DI- A thru F
Samples: Deionized water extractions
CPVC Pipe turnings/shavings
Extraction Temperature Range: 20.8 to 31.2 degrees Celsius

Sample ID	Wt., g	vol., mL	Day 1 pH	Day 2 pH	Day 3 pH	Day 4 pH	Day 5 pH
A - organo-tin sample	20.45	923	7.11	6.96	6.65	6.58	6.42
B - organic analysis sample	20.07	921	7.45	7.43	7.4	7.38	7.22
C - organo-tin spike	20.75	911	7.05	7.01	6.98	6.91	6.90
D - DI water only spike	-	936	-	-	-	-	-
E - organotin blank	-	995	-	-	-	-	-
F - organic analysis blank	-	995	-	-	-	-	-

No attempt was made to adjust pH over course of extractions

Spikes prepared as 5 microliters of a solution of 9.6 mg plictran in 20 mL acetone
2.4 micrograms added per spike

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2310 N. W. 55th Court #123 &124
Fort Lauderdale, Florida 33309
Tel: (954) 486-2233
Fax: (954) 486-2886

18 May 1998

File Number: 498324 A-F

West Coast Analytical Service, Inc.
9840 Alburtis Avenue
Santa Fe Springs, CA 96070
Atn: Eric Lindsay

Re: Analysis for organo-tins & drinking water organics for Thomas Reid Associates

Dear Mr. Lindsay:

Please find enclosed six glass jar (ca. 1L each) of de-ionized water extracts and controls for the Thomas Reid Associates project. Hopefully Mr. Reid has already alerted you to expect these samples and has discussed the required analyses. These samples should be reported directly to Mr. Thomas Reid and not ANRESCO. All billing for this project should go directly to Thomas Reid Associates, not ANRESCO. IF you need clarification, etc. please feel free to contact me at your convenience.

Client Contact: Mr. Thomas Reid (e-mail tra@igc.org)
Thomas Reid Associates
560 Waverly Street, Suite 201 - PO Box 880
Palo Alto, CA 94301 Phone: 650-327-0429 FAX 650-327-4024

Samples being submitted:
498324 A - DI water extract for organo-tin analysis {20.45g CPVC in 923mL) - pH 6.42
498324 B - DI water extract for organic compounds analysis{20.07g CPVC in 921mL} - pH 7.22
498324 C - DI water extract for organotin analysis spiked with 2.4 microgram Plictran - pH 6.90
(tricyclohexyl tin hydroxide, cyhexatin) {20.75g CPVC in 911mL)
498324 D - DI water only spiked with 2.4 microgram Plictran {blank spike, 936 mL}
498324 E - DI water blank for organo-tin analysis
498324 F - DI water blank for organic compounds analysis

Spikes were produced using 5 microliters of a solution of 9.6mg Plictran in 20mL acetone.

Best Regards;

E. Jerry Oliveras
Laboratory Director

F:\users\jerry\trawcas598.wpd

08

ANRESCO, Inc. File Number: 498324-CL- #1 thru #5
8 June 1998
Samples: Conditioning water extractions (chlorinated 2mg/L) pH 8
CPVC Pipe turnings/shavings
Extraction Temperature Range: 18.6 - 31.3 degrees Celsius

			Day 1		Day 2		Day 3		Day 4		Day 5	
Sample ID	Wt., g	vol., mL	pH	cr	pH	cr	pH	cr	pH	cr	pH	cr
#1 - organotin sample	20.77	968	8.11	<1	8.28	<1	8.39	<1	8.45	<1	8.58	<1
#2 - organotin spike	20.58	971	8.2	<1	8.31	<1	8.41	<1	8.63	<1	8.79	<1
#3 - organotin blank	-	995	8.14	2	8.36	2	8.65	<2	8.8	2	8.96	2
#4 - organic analysis sample	22.13	967	8.43	<1	8.69	<1	8.91	<1	9.11	<1	9.26	<1
#5 - organic analysis blank	-	995	8.41	2	8.58	2	8.88	<2	9.04	2	9.21	2

cr = chlorine residual - in order to conserve sample EM Science test strips were used to check chlorine residual
<1 denotes a low but detectable amount, additional 2mg/L chlorine added per day for all samples.
<2 denotes between 1&2 mg/L; made back to 2 with addition of 1 mg/L equivalent chlorine residual
No attempt was made to adjust pH over course of extractions

Spike prepared as 5 microliters of a solution of 9.6 mg plictran in 20 mL acetone; 2.4 micrograms added

Eagle-Picher
Certificate of Analysis

Organic and Inorganic Quality Assurance For Assistance Call 800-331-7425

Bottle Type & QA Level:U Level 1

Approved: Thomas J Woolard

Description:250mL Amber W.M. Packer Lot No.:U7142010

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SEMIVOLATILES ANALYTES	(pg/L)
Phenol	< 5
bis-(2-Chloroethyl)ether	< 5
2-Chlorophenol	< 5
2-Methylphenol	< 5
2,2'-oxybis (1-Chloropropane)	< 5
4-Methylphenol	< 5
N-Nitroso-di-n-propylamine	< 5
Hexachloroethane	< 5
Nitrobenzene	< 5
Isophorone	< 5
2-Nitrophenol	< 5
2,4-Dimethylphenol	< 5
bis-(2-Chloroethoxy)methane	< 5
2,4-Dichlorophenol	< 5
1,2,4-Trichlorobenzene	< 5
Naphthalene	< 5
4-Chloroaniline	< 5
Hexachlorobutadiene	< 5
4-Chloro-3-methylphenol	< 5
2-Methylnaphthalene	< 5
Hexachlorocyclopentadiene	< 5
2,4,6-Trichlorophenol	< 5
2,4,5-Trichlorophenol	< 20
2-Chloronaphthalene	< 5
2-Nitroaniline	< 20
Dimethylphthalate	< 5
Acenaphthylene	< 5
2,6-Dinitrotoluene	< 5
3-Nitroaniline	< 20
Acenaphthene	< 5
Benzyl alcohol*	< 5
1,2-Dichlorobenzene*	< 5
Benzoic Acid*	< 5
N-Nitrosodimethylamine*	< 5

SEMIVOLATILE ANALYTES	(pg/L)
2,4-Dinitrophenol	< 20
4-Nitrophenol	< 20
Dibenzofuran	< 5
2,4-Dinitrotoluene	< 5
Diethylphthalate	< 5
4-Chlorophenyl-phenylether	< 5
Fluorene	< 5
4-Nitroaniline	< 20
4,6-Dinitro-2-methylphenol	< 20
N-Nitrosodiphenylamine	< 5
4-Bromophenyl-phenylether	< 5
Hexachlorobenzene	< 5
Pentachlorophenol	< 20
Phenanthrene	< 5
Anthracene	< 5
Di-n-butylphthalate	< 5
Fluoranthene	< 5
Pyrene	< 5
Butylbenzylphthalate	< 5
3,3'-Dichlorobenzidine	< 5
Benzo(a)anthracene	< 5
Chrysene	< 5
bis-(2-Ethylhexyl)phthalate	< 5
Di-n-octylphthalate	< 5
Benzo(b)fluoranthene	< 5
Benzo(k)fluoranthene	< 5
Benzo(a)pyrene	< 5
Indeno(1,2,3-cd)pyrene	< 5
Dibenz(a,h)anthracene	< 5
Benzo(g,h,i)perylene	< 5
1,3-Dichlorobenzene*	< 5
Carbazole*	< 5
1,4-Dichlorobenzene*	< 5
Azobenzene*	< 5

INORGANIC ANALYTES		(pg/L)
Ag	(Silver)	< 5
Al	(Aluminum)	< 50
As	(Arsenic)	< 0.5
Ba	(Barium)	< 10
Be	(Beryllium)	< 0.5
Ca	(Calcium)	< 500
Cd	(Cadmium)	< 1
CN	(Cyanide)	< 10
Co	(Cobalt)	< 5
Cr	(Chromium)	< 5
Cu	(Copper)	< 5
F	(Fluoride)	< 200
Fe	(Iron)	< 50
Hg	(Mercury)	< 0.2
K	(Potassium)	< 100
Mg	(Magnesium)	< 50
Mn	(Manganese)	< 5
Na	(Sodium)	< 5000
Ni	(Nickel)	< 10
Pb	(Lead)	< 1
Sb	(Antimony)	< 2
Se	(Selenium)	< 2
Tl	(Thallium)	< 5
V	(Vanadium)	< 5
Zn	(Zinc)	< 10

PESTICIDE ANALYTES	(pg/L)
alpha-BHC	< 0.01
beta-BHC	< 0.01
delta-BHC	< 0.01
gamma-BHC (Lindane)	< 0.01
Heptachlor	< 0.01
Aldrin	< 0.01
Heptachlor epoxide	< 0.01
Endosulfan I	< 0.01
Dieldrin	< 0.02
4,4'-DDE	< 0.02
Endrin	< 0.02
Endosulfan II	< 0.02
4,4'-DDD	< 0.02
Endosulfan sulfate	< 0.02
4,4'-DDT	< 0.02
Methoxychlor	< 0.10
Endrin ketone	< 0.02
Endrin aldehyde	< 0.02
alpha-Chlordane	< 0.01
gamma-Chlordane	< 0.01
Toxaphene	< 1.0
Aroclor-1016, Aroclor-1232	< 0.20
Aroclor-1242, Aroclor-1248	< 0.20
Aroclor-1254, Aroclor-1260	< 0.20
Aroclor-1221	< 0.40
Aroclor-1262*, Aroclor-1268*	< 0.20

*Analyte not listed as a target compound in the OSWER Directive.

Eagle-Picher Technologies Division 200 B.J. Tunnell Blvd. Miami, OK 74354 Fax (918)540-1659

13 Extraction water preparation

13.1 Chemical characteristics

Four extraction waters shall be available for exposure:

a) pH = 5, with 2 mg/L available chlorine and 100 mg/L hardness;

b) pH = 6.5, with 2 mg/L available chlorine and 100 mg/L hardness;

c) pH = 8 (organic analysis), with 0 mg/L available chlorine and 100 mg/L hardness, and

d) pH = 10, with 2 mg/L available chlorine.

13.2 Reagents

13.2.1 Reagent water

Deionized water prepared to meet specifications for ASTM D 1193 Type II reagent water.

13.2.2 Phosphate buffer stock solutions (0.1M)

Dissolve 13.89 g sodium dihydrogen phosphate monohydrate in reagent water, dilute to 0.1L and mix thoroughly. Prepare fresh weekly. This buffer shall be used with only the magnesium hardness reagent.

13.2.3 Magnesium hardness stock solution (0.04M)

Dissolve 8.13 g magnesium chloride hexahydrate in reagent water, dilute to 1.0L, mix thoroughly. Prepare fresh weekly.

13.2.4 Chlorine stock solution (0.025M)

Dilute 7.3 ml reagent grade sodium hypochlorite (5 percent NaOCl) to 200 mL with reagent water. Store in tightly stoppered amber reagent bottle protected from light and stored at 20°C. Prepare fresh weekly.

13.2.4.1 Determining chlorine stock solution strength

Determine the strength of the chlorine stock solution by diluting 1.0 mL to 1.0 L with reagent water. Immediately analyze for total residual chlorine. Refer to this determination as A.

13.2.4.2 Determining amount of chlorine stock solution required to obtain 2% residual chlorine

To determine the volume of the chlorine stock solution necessary to add to the extraction water to obtain 2.0 mg/L chlorine residual, use the following formula:

$$\text{mL stock solution} = \frac{2.0 \quad B}{A}$$

where A = chlorine equivalent per mL of chlorine stock solution (determined above)

where B = liters of extraction water

13.2.5 Calcium hardness stock solution (0.04M)

Dissolve 4.44 g anhydrous calcium chloride in reagent water, dilute to 1.0L, mix thoroughly. Prepare fresh weekly.

13.2.6 Sodium bicarbonate buffer (0.04M)

Dissolve 3.36 g sodium bicarbonate in reagent water and dilute to 1.0 L mixing thoroughly. Prepare fresh weekly.

13.2.7 Sodium hydroxide solution (0.1M)

Dissolve 4.0 g of sodium hydroxide in reagent water, dilute to 1.0 L and mix well.

13.2.8 Sodium borate solution (0.05M)

Dissolve 19.07 g of sodium borate decahydrate ($Na_2B_4O_7 .10H_2O$) in reagent water, dilute to 1.0 L and mix well.

13.3 pH = 5 water

Prepare pH 5 extraction water to contain 100 mg/L hardness and 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in Table B17, shall be diluted to the desired water volume with reagent water.

13.4 pH = 6.5 water

Prepare pH = 6.5 water to contain 100 mg/L hardness and 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in Table B17 shall be diluted to the desired water volume with reagent water. The pH shall be adjusted to pH 6.5 (± 0.5) using 0.1M HCl.

13.5 pH = 8 water (conditioning)

Prepare pH 8 conditioning water to contain 100 mg/L hardness and 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in Table B17, shall be diluted to the desired water volume with reagent water.

13.6 pH = 8 water (organic analysis)

Prepare pH 8 organic extraction water to contain 100 mg/L hardness and 0 mg/L available chlorine. Stock reagent solutions in the amounts shown in Table B17 should be diluted to the desired water volume with reagent water.

13.7 pH = 10 water

Prepare pH 10 extraction water to contain 2 mg/L available chlorine. Stock reagent solutions in the amounts shown in Table B17, shall be diluted to the desired water volume with reagent water.

Table B17 – One liter volume of extraction water

pH	Solution #1	Solution #2	Chlorine stock solution
5	25 ml of 0.1M NaH_2PO_4	25 ml of 0.04M $MgCl_2$	see 13.2.4
6.5	25 ml of 0.04M $NaHCO_3$	25 ml of 0.04M $CaCl_2$	see 13.2.4
8 (conditioning)	25 ml of 0.04M $NaHCO_3$	25 ml of 0.04M $CaCl_2$	see 13.2.4
8 (organic)	25 ml of 0.04M $NaHCO_3$	25 ml of 0.04M $CaCl_2$	none
10	50 ml of 0.1 NaOH	50 ml of 0.05M $Na_2B_4O_7$	see 13.2.4

P

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT P

1998 Testing Results, Quanterra Environmental Services

MAY 27 199

Quanterra
Environmental Services

Quanterra Incorporated
880 Riverside Parkway
West Sacramento, California 95605

916 373-5600 Telephone
916 372-1059 Fax

May 22, 1998
QUANTERRA INCORPORATED PROJECT NUMBER: **098964**
PO/CONTRACT: **498324**

Thomas Reid
Thomas Reid Associates
560 Waverly Street, Suite 201
Palo Alto, CA 94301

Dear Mr. Reid:

This report contains the analytical results for the one solid sample which was received under letter of request by Quanterra Incorporated on 04 May1998.

The case narrative is an integral part of this report.

If you have any questions, please feel free to call.

Sincerely,

Jill M. Killmann
for

Terry A. Wilson
Project Manager
Advanced Technology

TW/rr

Quanterra
Environmental Services

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QUANTERRA INCORPORATED PROJECT NUMBER 098964

Case Narrative

Quanterra's Quality Assurance Program

Sample Description Information

Letter of Request

Polychlorinated Dioxins/Furans - Method 8290
Includes Sample(s): 1
- Method Blank Sheets
- Sample Data Sheets
- Laboratory Control Sample

Quanterra
Environmental Services

CASE NARRATIVE

QUANTERRA INCORPORATED PROJECT NUMBER 098964

Your sample was received at twenty degrees Celsius.

Detection limits for dioxins and furans are reported on a sample specific basis and all results are recovery corrected per the isotope dilution technique.

A 5.0 g aliquot of your sample was weighed out initially and extracted. Following extraction, one-tenth of this aliquot was used for analysis of the sample. All calculations are performed based on the final sample weight (i.e., 0.502 g).

The ^{13}C-1,2,3,7,8-PeCDF and ^{13}C-1,2,3,7,8-PeCDD internal standard recoveries in the laboratory control sample associated with your sample are slightly lower than the method recommended goal of 40%. Generally, data quality is not considered affected if internal standard signal-to-noise is greater than 10:1, which is achieved for all internal standards in all samples.

Quanterra
Environmental Services

QUANTERRA INCORPORATED QUALITY CONTROL PROGRAM

Quanterra has implemented an extensive Quality Control (QC) program to ensure the production of scientifically sound, legally defensible data of known documentable quality. This QC program is based upon requirements in "Test Methods for Evaluating Solid Waste", USEPA SW-846, Third Edition. It applies whenever SW-846 analytical methods are used. It also applies in whole or in part whenever project requirements fail to specify some aspect of QC practices described here. It does not apply when other well defined QC programs (e.g. CLP or CLP-like) are specified. This is Quanterra's base QC program for environmental analysis.

Definitions:

Quality Control Batch. The quality control (QC) batch is a set of up to 20 field samples plus associated laboratory QC samples that are similar in composition (matrix) and that are processed within the same time period with the same reagent and standard lots.

Surrogate. A surrogate (or internal standard) is an organic compound similar in chemical behavior to the target analyte, but not normally found in environmental samples. Surrogates (or IS) are added to all samples in a batch to monitor the effects of both the matrix and the analytical process on accuracy.

Method Blank. A method blank (MB) is a control sample prepared using the same reagents used for the samples. As part of the QC batch, it accompanies the samples through all steps of the sample extraction and cleanup procedure. The method blank is used to monitor the level of contamination introduced to a batch of samples as a result of processing in the laboratory.

Laboratory Control Sample. A laboratory control sample (LCS) is prepared using a well characterized matrix (e.g., reagent water or Ottawa sand) that is spiked with known amounts of representative analytes. Alternate matrices (e.g., glass beads) may be used for soil analyses when Ottawa sand is not appropriate. As part of a QC batch, it accompanies the samples through all steps of the sample extraction and cleanup process. The LCS is used to monitor the accuracy of the analytical process independent of possible interference effects due to sample matrix.

Duplicate Control Sample. A duplicate laboratory control sample (DCS) consists of a pair of LCSs analyzed within the same QC batch to monitor precision and accuracy independent of sample matrix effects.

Quanterra
Environmental Services

SAMPLE DESCRIPTION INFORMATION
for
Thomas Reid Associates

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
098964-0001-MB	Method Blank	SOLID			04 MAY 98
098964-0001-SA	498324 CPVC Pipe Shavings	SOLID	01 MAY 98		04 MAY 98

ANRESCO

INCORPORATED

ANALYSIS RESEARCH CONSULTING

HEADQUARTERS
1370 Van Dyke Ave., San Francisco, CA 94124
Tel: (415) 822-1100 Fax: (415) 822-6615

Toll Free: 800-359-0920

790 Basin Street, #2
San Pedro, California 90731
Tel: (310) 833-4598
Fax: (310) 833-1585

2310 N. W. 55th Court #123 &124
Fort Lauderdale, Florida 33309
Tel: (954) 486-2233
Fax: (954) 486-2886

1 May 1998

ANRESCO File Number: 498324
TRA - CPVC pipe - Dioxins

Quanterra
880 Riverside Parkway
West Sacramento, CA 95605

Atn: Terry Wilson or Eric Redmond Phone: 916-374-4358 FAX: 916-373-5600

Re: Testing of CPVC pipe shavings for Thomas Reid Associates

Dear Terry & Eric:

Please find enclosed two 250mL wide mouth amber glass jars (specially pre-cleaned to EPA Level 1 by Eagle-Picher) with teflon lined lids. Each jar contains about 45 grams of the same composite sample of CPVC pipe shavings prepared by ANRESCO for this project. **The two jars should be considered one sample.** I understand you have been contact by Thomas Reid of Thomas Reid Associates regarding the required testing on this sample. General instructions are solvent extract and screen for dioxins (PCDD PCDF test) and **report the results to TRA only not ANRESCO.** Billing should be made to Thomas Reid Associates. If you have any questions or concerns please feel free to contact me at your convenience at our San Francisco Headquarters, ext. 18.

Best Regards;

E. Jerry Oliveras
Laboratory Director

F:\users\jerry\tradioxins.wpd

enclosures: page 3 of TRA letter/protocol to ANRESCO
Eagle-Picher sample bottle Certificate
2 x 250 amber glass bottles marked "498324 - CPVC pipe shavings" - one sample

Received By: [signature] 050498 10:20
Rec'd in good condition. 050498 [signature]

Anresco Start-up

Acquire materials:

60 feet of ½ inch CPVC pipe for potable water (6 10-foot lengths).
Joints and fittings (see attached diagram)
Approved CPVC primer and cement
continuous flow pump (Teco or equivalent)
inert tubing and containers for filling and sampling pipe cell

Priority

Please proceed to initiate the dioxin testing immediately.

1. Dioxin
   a. Sample (Anresco)
      i. Locally available CPVC pipe rated for potable water ("CPVC-pw")
      ii. Record markings on pipe in full
      iii. Sand surface clean with 80 grit paper, wipe with water
      iv. Use electric drill to produce plastic turnings
         (1) pre-clean electric drill bit with toluene or acetone
         (2) Use low speed, verify that drill bit has not warmed appreciably (not too hot to touch)
         (3) Need 50 to 100 grams total
         (4) One sample
      v. Pack in appropriate container
      vi. Ship to Quanterra with notice to TRA

   b. Analysis (Quanterra)
      i. Solvent extraction for screening
      ii. Full PCDD PCDF test
      iii. Report results to TRA

Further instructions to follow.

###TSR

THOMAS REID ASSOCIATES
560 WAVERLEY STREET, SUITE 201
P.O. BOX 880 PALO ALTO, CA 94301

Tel: 650-327-0429
Fax: 650-327-4024
Email: tra@igc.org

Eagle-Picher
Certificate of Analysis

Organic and Inorganic Quality Assurance For Assistance Call 800-331-7425

Bottle Type & QA Level:U Level 1

Approved: Thomas J. Worland

Description:250mL Amber W.M. Packer Lot No.:U7142010

Eagle-Picher Level 1 products have been tested and found to comply with or to be lower than the EPA detection limits as stated in OSWER Directive # 9240.0-05A "Specifications And Guidance For Contaminant-Free Sample Containers 12/92". Eagle-Picher pass/fail criteria considers all significant non-target compounds.

SEMIVOLATILES ANALYTES	(µg/L)
Phenol	< 5
bis-(2-Chloroethyl)ether	< 5
2-Chlorophenol	< 5
2-Methylphenol	< 5
2,2'-oxybis (1-Chloropropane)	< 5
4-Methylphenol	< 5
N-Nitroso-di-n-propylamine	< 5
Hexachloroethane	< 5
Nitrobenzene	< 5
Isophorone	< 5
2-Nitrophenol	< 5
2,4-Dimethylphenol	< 5
bis-(2-Chloroethoxy)methane	< 5
2,4-Dichlorophenol	< 5
1,2,4-Trichlorobenzene	< 5
Naphthalene	< 5
4-Chloroaniline	< 5
Hexachlorobutadiene	< 5
4-Chloro-3-methylphenol	< 5
2-Methylnaphthalene	< 5
Hexachlorocyclopentadiene	< 5
2,4,6-Trichlorophenol	< 5
2,4,5-Trichlorophenol	< 20
2-Chloronaphthalene	< 5
2-Nitroaniline	< 20
Dimethylphthalate	< 5
Acenaphthylene	< 5
2,6-Dinitrotoluene	< 5
3-Nitroaniline	< 20
Acenaphthene	< 5
Benzyl alcohol*	< 5
1,2-Dichlorobenzene*	< 5
Benzoic Acid*	< 5
N-Nitrosodimethylamine*	< 5

SEMIVOLATILE ANALYTES	(µg/L)
2,4-Dinitrophenol	< 20
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Fluorene	< 5
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Pyrene	< 5
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3,3'-Dichlorobenzidine	< 5
Benzo(a)anthracene	< 5
Chrysene	< 5
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Di-n-octylphthalate	< 5
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Benzo(k)fluoranthene	< 5
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Benzo(g,h,i)perylene	< 5
1,3-Dichlorobenzene*	< 5
Carbazole*	< 5
1,4-Dichlorobenzene*	< 5
Azobenzene*	< 5

INORGANIC ANALYTES		(µg/L)
Ag	(Silver)	< 5
Al	(Aluminum)	< 50
As	(Arsenic)	< 0.5
Ba	(Barium)	< 10
Be	(Beryllium)	< 0.5
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Cr	(Chromium)	< 5
Cu	(Copper)	< 5
F	(Fluoride)	< 200
Fe	(Iron)	< 50
Hg	(Mercury)	< 0.2
K	(Potassium)	< 100
Mg	(Magnesium)	< 50
Mn	(Manganese)	< 5
Na	(Sodium)	< 5000
Ni	(Nickel)	< 10
Pb	(Lead)	< 1
Sb	(Antimony)	< 2
Se	(Selenium)	< 2
Tl	(Thallium)	< 5
V	(Vanadium)	< 5
Zn	(Zinc)	< 10

PESTICIDE ANALYTES	(µg/L)
alpha-BHC	< 0.01
beta-BHC	< 0.01
delta-BHC	< 0.01
gamma-BHC (Lindane)	< 0.01
Heptachlor	< 0.01
Aldrin	< 0.01
Heptachlor epoxide	< 0.01
Endosulfan I	< 0.01
Dieldrin	< 0.02
4,4'-DDE	< 0.02
Endrin	< 0.02
Endosulfan II	< 0.02
4,4'-DDD	< 0.02
Endosulfan sulfate	< 0.02
4,4'-DDT	< 0.02
Methoxychlor	< 0.10
Endrin ketone	< 0.02
Endrin aldehyde	< 0.02
alpha-Chlordane	< 0.01
gamma-Chlordane	< 0.01
Toxaphene	< 1.0
Aroclor-1016, Aroclor-1232	< 0.20
Aroclor-1242, Aroclor-1248	< 0.20
Aroclor-1254, Aroclor-1260	< 0.20
Aroclor-1221	< 0.40
Aroclor-1262*, Aroclor-1268*	< 0.20

*Analyte not listed as a target compound in the OSWER Directive.

Eagle-Picher Technologies Division 200 B.J. Tunnell Blvd. Miami, OK 74354 Fax (918)540-1659

Quanterra
Environmental Services

POLYCHLORINATED DIOXINS/FURANS
ISOMER SPECIFIC ANALYSIS
Method 8290

Client Name: Thomas Reid Associates
Client ID: Method Blank
Lab ID: 098964-0001-MB
Matrix: SOLID Sampled: NA Received: NA
Authorized: 04 MAY 98 Prepared: 11 MAY 98 Analyzed: 20 MAY 98

Sample Amount 10.0 G
Column Type DB-5

Parameter	Result	Units	Detection Limit	Data Qualifiers
Furans				
TCDFs (total)	ND	pg/g	0.23	
2,3,7,8-TCDF	ND	pg/g	0.23	
PeCDFs (total)	ND	pg/g	0.26	
1,2,3,7,8-PeCDF	ND	pg/g	0.25	
2,3,4,7,8-PeCDF	ND	pg/g	0.26	
HxCDFs (total)	ND	pg/g	0.77	
1,2,3,4,7,8-HxCDF	ND	pg/g	0.58	
1,2,3,6,7,8-HxCDF	ND	pg/g	0.57	
2,3,4,6,7,8-HxCDF	ND	pg/g	0.67	
1,2,3,7,8,9-HxCDF	ND	pg/g	0.77	
HpCDFs (total)	ND	pg/g	0.17	
1,2,3,4,6,7,8-HpCDF	ND	pg/g	0.14	
1,2,3,4,7,8,9-HpCDF	ND	pg/g	0.17	
OCDF	ND	pg/g	1.1	
Dioxins				
TCDDs (total)	ND	pg/g	0.24	
2,3,7,8-TCDD	ND	pg/g	0.24	
PeCDDs (total)	ND	pg/g	0.42	
1,2,3,7,8-PeCDD	ND	pg/g	0.42	
HxCDDs (total)	ND	pg/g	0.43	
1,2,3,4,7,8-HxCDD	ND	pg/g	0.43	
1,2,3,6,7,8-HxCDD	ND	pg/g	0.41	
1,2,3,7,8,9-HxCDD	ND	pg/g	0.40	
HpCDDs (total)	ND	pg/g	0.44	
1,2,3,4,6,7,8-HpCDD	ND	pg/g	0.19	
OCDD	ND	pg/g	1.4	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Teri Stone Approved By: Clark Pickell

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

POLYCHLORINATED DIOXINS/FURANS
ISOMER SPECIFIC ANALYSIS (CONT.)
Method 8290

Client Name: Thomas Reid Associates
Client ID: Method Blank
Lab ID: 098964-0001-MB
Matrix: SOLID
Authorized: 04 MAY 98

Sampled: NA
Prepared: 11 MAY 98

Received: NA
Analyzed: 20 MAY 98

Sample Amount 10.0 G
Column Type DB-5

	% Recovery
13C-2,3,7,8-TCDF	47
13C-2,3,7,8-TCDD	72
13C-1,2,3,7,8-PeCDF	44
13C-1,2,3,7,8-PeCDD	49
13C-1,2,3,4,7,8-HxCDF	65
13C-1,2,3,6,7,8-HxCDD	68
13C-1,2,3,4,6,7,8-HpCDF	78
13C-1,2,3,4,6,7,8-HpCDD	84
13C-OCDD	85

ND = Not detected
NA = Not applicable

Reported By: Teri Stone

Approved By: Clark Pickell

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

POLYCHLORINATED DIOXINS/FURANS
ISOMER SPECIFIC ANALYSIS
Method 8290

Client Name: Thomas Reid Associates
Client ID: 498324 CPVC Pipe Shavings
Lab ID: 098964-0001-SA
Matrix: SOLID Sampled: 01 MAY 98 Received: 04 MAY 98
Authorized: 04 MAY 98 Prepared: 11 MAY 98 Analyzed: 17 MAY 98

Sample Amount 5.0 G
Column Type DB-5

Parameter	Result	Units	Detection Limit	Data Qualifiers
Furans				
TCDFs (total)	50	pg/g	--	
2,3,7,8-TCDF	ND	pg/g	9.9	g
PeCDFs (total)	ND	pg/g	17	
1,2,3,7,8-PeCDF	ND	pg/g	5.6	
2,3,4,7,8-PeCDF	ND	pg/g	5.9	
HxCDFs (total)	ND	pg/g	9.1	
1,2,3,4,7,8-HxCDF	ND	pg/g	9.1	
1,2,3,6,7,8-HxCDF	ND	pg/g	3.4	
2,3,4,6,7,8-HxCDF	ND	pg/g	3.8	
1,2,3,7,8,9-HxCDF	ND	pg/g	4.3	
HpCDFs (total)	ND	pg/g	9.5	
1,2,3,4,6,7,8-HpCDF	ND	pg/g	9.5	
1,2,3,4,7,8,9-HpCDF	ND	pg/g	3.6	
OCDF	110	pg/g	--	j
Dioxins				
TCDDs (total)	ND	pg/g	6.2	
2,3,7,8-TCDD	ND	pg/g	2.3	
PeCDDs (total)	ND	pg/g	21	
1,2,3,7,8-PeCDD	ND	pg/g	6.1	
HxCDDs (total)	ND	pg/g	8.3	
1,2,3,4,7,8-HxCDD	ND	pg/g	8.3	
1,2,3,6,7,8-HxCDD	ND	pg/g	7.5	
1,2,3,7,8,9-HxCDD	ND	pg/g	7.0	
HpCDDs (total)	ND	pg/g	8.2	
1,2,3,4,6,7,8-HpCDD	ND	pg/g	8.2	
OCDD	ND	pg/g	86	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Adrian Messecar Approved By: Clark Pickell

The cover letter is an integral part of this report.
Rev 230787

Quanterra
Environmental Services

POLYCHLORINATED DIOXINS/FURANS
ISOMER SPECIFIC ANALYSIS (CONT.)
Method 8290

Client Name: Thomas Reid Associates
Client ID: 498324 CPVC Pipe Shavings
Lab ID: 098964-0001-SA
Matrix: SOLID
Authorized: 04 MAY 98
Sampled: 01 MAY 98
Prepared: 11 MAY 98
Received: 04 MAY 98
Analyzed: 17 MAY 98

Sample Amount 5.0 G
Column Type DB-5

	% Recovery
13C-2,3,7,8-TCDF	50
13C-2,3,7,8-TCDD	51
13C-1,2,3,7,8-PeCDF	53
13C-1,2,3,7,8-PeCDD	54
13C-1,2,3,4,7,8-HxCDF	65
13C-1,2,3,6,7,8-HxCDD	55
13C-1,2,3,4,6,7,8-HpCDF	71
13C-1,2,3,4,6,7,8-HpCDD	72
13C-OCDD	68

Note g : 2,3,7,8-TCDF results have been confirmed on a DB-225 column.

Note j : Result is an estimated value that is below the lower calibration limit but above the target limit.

ND = Not detected
NA = Not applicable

Reported By: Adrian Messecar
Approved By: Clark Pickell

The cover letter is an integral part of this report.
Rev 230787

Q

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT Q

1998 Testing Results, West Coast Analytical Service, Inc.

WEST COAST
ANALYTICAL
SERVICE, INC.
Analytical Chemists

June 4, 1998

THOMAS REID ASSOCIATES
P. O. Box 880
Palo Alto, CA 94301

Attn: Thomas Reid

Job No: 38222 S

LABORATORY REPORT

Samples Received: Six (6) Liquids
Date Received: 05/21/98
Purchase Order No: Verbal- Thomas Reid

The samples were analyzed as follows:

Analysis	Page
Organotins by GC/FPD	2 - 7
GCMS Volatile Screen for Organic Constituents	8
Selected Metals by ICPMS	9 - 10

Charles Jacks, Ph.D.
Senior Staff Chemist

D.J. Northington, Ph.D.
President

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Sample: METHOD BLANK

Organotins by GC/FPD

Date Received: 05-21-98
Date Extracted: 05-27-98
Date Analyzed: 05-29-98
Instrument ID: GC #13

Matrix: Water
Sample amount: 800mL:2mL

Units: ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	ND	0.05
Dibutyltin	ND	0.05
Tributyltin	ND	0.05
Tetrabutyltin	ND	0.05

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	96	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Sample: 498324-A

Organotins by GC/FPD

Date Received: 05-21-98
Date Extracted: 05-27-98
Date Analyzed: 05-29-98,06-01-98
Instrument ID: GC #13

Matrix: Water
Sample amount: 800mL:2mL
Units: ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	1.5	0.05
Dibutyltin	33	0.05
Tributyltin	0.1	0.05
Tetrabutyltin	0.1	0.05

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	113	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Sample: 498324-C

Organotins by GC/FPD

Date Received: 05-21-98
Date Extracted: 05-27-98
Date Analyzed: 05-29-98,06-01-98
Instrument ID: GC #13

Matrix: Water
Sample amount: 820mL:2mL
Units: ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	1.5	0.05
Dibutyltin	21	0.05
Tributyltin	0.1	0.05
Tetrabutyltin	ND	0.05

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	82	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Sample: 498324-D

Organotins by GC/FPD

Date Received: 05-21-98
Date Extracted: 05-27-98
Date Analyzed: 05-29-98
Instrument ID: GC #13

Matrix: Water
Sample amount: 850mL:2mL
Units: ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	ND	0.05
Dibutyltin	ND	0.05
Tributyltin	ND	0.05
Tetrabutyltin	ND	0.05

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	70	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Sample: 498324-E

Organotins by GC/FPD

Date Received: 05-21-98
Date Extracted: 05-27-98
Date Analyzed: 05-29-98
Instrument ID: GC #13

Matrix: Water
Sample amount: 780mL:2mL

Units: ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	ND	0.05
Dibutyltin	ND	0.05
Tributyltin	ND	0.05
Tetrabutyltin	ND	0.05

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	79	50-150

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THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Organotins by GC/FPD

Matrix Spike/Matrix Spike Duplicate Recovery Summary

QC Batch: Batch QC
Date Analyzed: 05-29-98

Matrix: Water
Date Extracted: 05-27-98
Units: ppb

Analyte	Sample Result	Amount Spiked	MS Result	% Rec MS	MSD Result	% Rec MSD	RPD
MBT	ND	1.4	0.13	9	0.17	12	27
DBT	ND	1.65	0.954	58	1.34	81	34
TBT	ND	1.41	0.99	70	1.28	91	26
TeBT	ND	1.31	0.95	73	1.32	101	33

QC Limits

Analyte	RPD Control	% Recovery Control	
Monobutyltin	35	0	100
Dibutyltin	35	30	110
Tributyltin	35	50	150
Tetrabutyltin	35	50	150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

GCMS Volatile Screen for Organic Constituents

Sample Preparation

5mL of the samples were each loaded into individual purge vessels. Internal standards and surrogates were then spiked into the purge vessel. The samples were analyzed by purge and trap GC/MS. The results are given below.

GC/MS Conditions

GC Column:	25m x 0.20mm HP-624, 1.12 micron film (Hewlett Packard)
GC Conditions:	35°C (hold 4 min), program to 200°C at 8 /min, then hold for 1.87 min.
Injector:	220°C
Scan Range:	35-300 amu, 2.78 scans/second

GCMS Volatile Screen for Organic Constituents *

Parts per Billion (ug/L)

Compound	498324 B	498324 F	Detection Limit
Acetone **	9	ND	5
Chloroform **	18	10	1
1,1,1,2-Tetrafluoroethane	5	ND	5
Acetaldehyde	5	ND	5
Diethyl ether	5	ND	5

Date analyzed: 5/27/98

* - The GCMS screen is designed to be qualitative and semi-quantitative (except as noted). There may be other components in the sample which were too volatile, non-volatile, or thermally labile to be detected. The values have also not been corrected for different component responses, therefore the results are only semi-quantitative estimates. More accurate quantitation may be obtained through additional analysis using standards.

** - Results are quantitated using a standard.

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Selected Metals
Quantitative Analysis Report
Inductively Coupled Plasma - Mass Spectrometry

Parts Per Billion (ug/l)

lement	498324 A	498324 C	Detection Limit
ntimony	0.33	0.12	0.03
admium	0.1	0.06	0.01
ead	13	4.7	0.08

Date Analyzed: 5-29-98

Selected Metals
Quantitative Analysis Report
Inductively Coupled Plasma - Mass Spectrometry

Parts Per Billion (ug/l)

lement	498324 D	498324 E	Detection Limit
Antimony	ND	ND	0.03
admium	ND	ND	0.01
Lead	0.13	ND	0.08

ate Analyzed: 5-29-98

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38222
June 4, 1998

LABORATORY REPORT

Quality Control Summary

Sample: 498324 A
Matrix: Water

Parts Per Billion (ug/l)

	Sample	Spike Conc.	MS	MS %Rec	MSD	MSD %Rec	Spike %RPD
Antimony	0.33	500	510	102	520	104	1.9
Cadmium	0.1	500	480	96	490	98	2.1
Lead	13	500	540	105	530	103	1.9

Date Analyzed: 5-29-98

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Abbreviations Summary

General Reporting Abbreviations:

B — Blank - Indicates that the compound was found in both the sample and the blank. The sample value is reported without blank subtraction. If the sample value is less than 10X the blank value times the sample dilution factor, the compound may be present as a laboratory contaminant.

D — Indicates that the sample was diluted, and consequently the surrogates were too dilute to accurately measure.

DL — Detection Limit - Is the minimum value which we believe can be detected in the sample with a high degree of confidence, taking into account dilution factors and interferences. The reported detection limits are equal to or greater than Method Detection Limits (MDL) to allow for day to day and instrument to instrument variations in sensitivity.

J — Indicates that the value is an estimate.

ND — Not Detected - Indicates that the compound was not found in the sample at or above the detection limit.

ppm
ppb — Parts per million (billion) in liquids is usually equivalent to mg/l (ug/l), or in solids to mg/kg (ug/kg). In the gas phase it is equivalent to ul/l (ul/m^3).

TR — Trace - Indicates that the compound was observed at a value less than our normal reported Detection Limit (DL), but we feel its presence may be important to you. These values are subject to large errors and low degrees of confidence.

kg	kilogram	mg	milligram	l	liter	m	meter
g	gram	ug	microgram	ul	microliter		

QC Abbreviations:

Control & Warning Limits — QC Limits are determined from historical data. The test value must be within the Control Limits for the test to be considered valid. Based on historical data, the confidence intervals are 95% for warning limits and 99% for control limits.

% Error — Percent Error - This is a measure of accuracy based on the analysis of a Laboratory Control Standard (LCS). An LCS is a reference sample of known value such as an NIST Standard Reference Material (SRM). The % Error is expressed in percent as the difference between the known value and the experimental value, divided by the known value. The LCS may simply be a solution based standard which confirms calibration (ICV or CCV - initial or continuing calibration verification), or it may be a reference sample taken through preparation and analysis.

ANRESCO

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ANALYSIS RESEARCH CONSULTING

HEADQUARTERS
1370 Van Dyke Ave., San Francisco, CA 94124
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Toll Free: 800-359-0920

790 Basin Street, #2
San Pedro, California 90731
Tel: (310) 833-4598
Fax: (310) 833-1585

2310 N. W. 55th Court #123 &124
Fort Lauderdale, Florida 33309
Tel: (954) 486-2233
Fax: (954) 486-2886

18 May 1998

File Number: 498324 A-F

West Coast Analytical Service, Inc.
9840 Alburtis Avenue
Santa Fe Springs, CA 96070
Atn: Eric Lindsay

Re: Analysis for organo-tins & drinking water organics for Thomas Reid Associates

Dear Mr. Lindsay:

Please find enclosed six glass jar (ca. 1L each) of de-ionized water extracts and controls for the Thomas Reid Associates project. Hopefully Mr. Reid has already alerted you to expect these samples and has discussed the required analyses. These samples should be reported directly to Mr. Thomas Reid and not ANRESCO. All billing for this project should go directly to Thomas Reid Associates, not ANRESCO. IF you need clarification, etc. please feel free to contact me at your convenience.

Client Contact: Mr. Thomas Reid (e-mail tra@igc.org)
Thomas Reid Associates
560 Waverly Street, Suite 201 - PO Box 880
Palo Alto, CA 94301 Phone: 650-327-0429 FAX 650-327-4024

Samples being submitted:

- 498324 A - DI water extract for organo-tin analysis {20.45g CPVC in 923mL) - pH 6.42
- 498324 B - DI water extract for organic compounds analysis{20.07g CPVC in 921mL} - pH 7.22
- 498324 C - DI water extract for organotin analysis spiked with 2.4 microgram Plictran - pH 6.90 (tricyclohexyl tin hydroxide, cyhexatin) {20.75g CPVC in 911mL)
- 498324 D - DI water only spiked with 2.4 microgram Plictran {blank spike, 936 mL}
- 498324 E - DI water blank for organo-tin analysis
- 498324 F - DI water blank for organic compounds analysis

Spikes were produced using 5 microliters of a solution of 9.6mg Plictran in 20mL acetone.

Best Regards;

E. Jerry Oliveras
Laboratory Director

RELINQUISHED BY: U. S. Mail F:\users\jerry\trawcas598.wpd
RECEIVED BY: Andrea Wright
WCAS JN: No 38222 Date 5/21/98 Time 7:40 AM

WCAS
WEST COAST
ANALYTICAL
SERVICE, INC.
Analytical Chemists

June 15, 1998

THOMAS REID ASSOCIATES
P.O. Box 880
Palo Alto, CA 94301

Attn: Thomas Reid

Job No: 38365 S

LABORATORY REPORT

Samples Received: Four (4) Liquids
Date Requested: 06/09/98
Purchase Order No: VERBAL-THOMAS REID

The samples were analyzed as follows:

Analysis	Page
Tin by ICPMS	2

Charles Jacks, Ph.D.
Senior Staff Chemist

D.J. Northington, Ph.D.
President

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B

WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38365
June 15, 1998

LABORATORY REPORT

Tin
Quantitative Analysis Report
Inductively Coupled Plasma - Mass Spectrometry

Parts Per Billion (ug/l)

Sample ID	Tin
498324 A	35
498324 C	29
498324 D	7
498324 E	8
Detection Limit	0.06

Date Analyzed: 5-29-98

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WCAS

B

Abbreviations Summary

General Reporting Abbreviations:

B Blank - Indicates that the compound was found in both the sample and the blank. The sample value is reported without blank subtraction. If the sample value is less than 10X the blank value times the sample dilution factor, the compound may be present as a laboratory contaminant.

D Indicates that the sample was diluted, and consequently the surrogates were too dilute to accurately measure.

DL Detection Limit - Is the minimum value which we believe can be detected in the sample with a high degree of confidence, taking into account dilution factors and interferences. The reported detection limits are equal to or greater than Method Detection Limits (MDL) to allow for day to day and instrument to instrument variations in sensitivity.

J Indicates that the value is an estimate.

ND Not Detected - Indicates that the compound was not found in the sample at or above the detection limit.

ppm
ppb Parts per million (billion) in liquids is usually equivalent to mg/l (ug/l), or in solids to mg/kg (ug/kg). In the gas phase it is equivalent to ul/l (ul/m^3).

TR Trace - Indicates that the compound was observed at a value less than our normal reported Detection Limit (DL), but we feel its presence may be important to you. These values are subject to large errors and low degrees of confidence.

kg	kilogram	mg	milligram	l	liter	m	meter
g	gram	ug	microgram	ul	microliter		

QC Abbreviations:

Control & Warning Limits QC Limits are determined from historical data. The test value must be within the Control Limits for the test to be considered valid. Based on historical data, the confidence intervals are 95% for warning limits and 99% for control limits.

% Error Percent Error - This is a measure of accuracy based on the analysis of a Laboratory Control Standard (LCS). An LCS is a reference sample of known value such as an NIST Standard Reference Material (SRM). The % Error is expressed in percent as the difference between the known value and the experimental value, divided by the known value. The LCS may simply be a solution based standard which confirms calibration (ICV or CCV - initial or continuing calibration verification), or it may be a reference sample taken through preparation and analysis.

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2310 N. W. 55th Court #123 &124
Fort Lauderdale, Florida 33309
Tel: (954) 486-2233
Fax: (954) 486-2886

18 May 1998

File Number: 498324 A-F

West Coast Analytical Service, Inc.
9840 Alburtis Avenue
Santa Fe Springs, CA 96070
Atn: Eric Lindsay

Re: Analysis for organo-tins & drinking water organics for Thomas Reid Associates

Dear Mr. Lindsay:

Please find enclosed six glass jar (ca. 1L each) of de-ionized water extracts and controls for the Thomas Reid Associates project. Hopefully Mr. Reid has already alerted you to expect these samples and has discussed the required analyses. These samples should be reported directly to Mr. Thomas Reid and not ANRESCO. All billing for this project should go directly to Thomas Reid Associates, not ANRESCO. IF you need clarification, etc. please feel free to contact me at your convenience.

Client Contact: Mr. Thomas Reid (e-mail tra@igc.org)
Thomas Reid Associates
560 Waverly Street, Suite 201 - PO Box 880
Palo Alto, CA 94301 Phone: 650-327-0429 FAX 650-327-4024

Samples being submitted:

- 498324 A - DI water extract for organo-tin analysis {20.45g CPVC in 923mL) - pH 6.42
- 498324 B - DI water extract for organic compounds analysis{20.07g CPVC in 921mL} - pH 7.22
- 498324 C - DI water extract for organotin analysis spiked with 2.4 microgram Plictran - pH 6.90 (tricyclohexyl tin hydroxide, cyhexatin) {20.75g CPVC in 911mL)
- 498324 D - DI water only spiked with 2.4 microgram Plictran {blank spike, 936 mL}
- 498324 E - DI water blank for organo-tin analysis
- 498324 F - DI water blank for organic compounds analysis

Spikes were produced using 5 microliters of a solution of 9.6mg Plictran in 20mL acetone.

'Best Regards;

E. Jerry Oliveras
Laboratory Director

RE'INQUISHED BY: U. S. Mail F:\users\jerry\trawcas598.wpd
RECEIVED BY: Andrea Wright
WORK #: 38222 DATE: 5/21/98 10AM

ANRESCO

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ANALYSIS RESEARCH CONSULTING

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Toll Free: 800-359-0920

790 Basin Street, #2
San Pedro, California 90731
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2310 N. W. 55th Court #123 &124
Fort Lauderdale, Florida 33309
Tel: (954) 486-2233
Fax: (954) 486-2886

18 May 1998

File Number: 498324 A-F

West Coast Analytical Service, Inc.
9840 Alburtis Avenue
Santa Fe Springs, CA 96070
Atn: Eric Lindsay

Re: Analysis for organo-tins & drinking water organics for Thomas Reid Associates

Dear Mr. Lindsay:

Please find enclosed six glass jar (ca. 1L each) of de-ionized water extracts and controls for the Thomas Reid Associates project. Hopefully Mr. Reid has already alerted you to expect these samples and has discussed the required analyses. These samples should be reported directly to Mr. Thomas Reid and not ANRESCO. All billing for this project should go directly to Thomas Reid Associates, not ANRESCO. IF you need clarification, etc. please feel free to contact me at your convenience.

Client Contact: Mr. Thomas Reid (e-mail tra@igc.org)
Thomas Reid Associates
560 Waverly Street, Suite 201 - PO Box 880
Palo Alto, CA 94301 Phone: 650-327-0429 FAX 650-327-4024

Samples being submitted:

- 498324 A - DI water extract for organo-tin analysis {20.45g CPVC in 923mL) - pH 6.42
- 498324 B - DI water extract for organic compounds analysis{20.07g CPVC in 921mL} - pH 7.22
- 498324 C - DI water extract for organotin analysis spiked with 2.4 microgram Plictran - pH 6.90 (tricyclohexyl tin hydroxide, cyhexatin) {20.75g CPVC in 911mL)
- 498324 D - DI water only spiked with 2.4 microgram Plictran {blank spike, 936 mL}
- 498324 E - DI water blank for organo-tin analysis
- 498324 F - DI water blank for organic compounds analysis

Spikes were produced using 5 microliters of a solution of 9.6mg Plictran in 20mL acetone.

Best Regards;

E. Jerry Oliveras
Laboratory Director

RELINQUISHED BY: U. S. Mail F:\users\jerry\trawcas598.wpd
RECEIVED BY: Todd A Wright
WCAS JN: No 38222 Date 5/21/98 Time 7:40AM

JUN 17 1998

WCAS
WEST COAST
ANALYTICAL
SERVICE, INC.
Analytical Chemists

June 15, 1998

THOMAS REID ASSOCIATES
P.O. Box 880
Palo Alto, CA 94301

Attn: Thomas Reid

Job No: 38369 S

LABORATORY REPORT

Samples Received: Five (5) Liquids
Date Received: 06/09/98
Purchase Order No: VERBAL-THOMAS REID

The samples were analyzed as follows:

Analysis	Page
Organotins by GC/FPD	2 - 6
GCMS Volatile Screen for Organic Constituents	7 - 8

Charles Jacks, Ph.D.
Senior Staff Chemist

D.J. Northington, Ph.D.
President

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

Sample: METHOD BLANK

Organotins by GC/FPD

Date Received:	06-09-98	Matrix:	Water
Date Extracted:	06-10-98	Sample amount:	1000mL:2mL
Date Analyzed:	06-11-98		
Instrument ID:	GC #13	Units:	ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	ND	0.02
Dibutyltin	ND	0.02
Tributyltin	ND	0.04
Tetrabutyltin	ND	0.02

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	89	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

Sample: 498324-C1-#1

Organotins by GC/FPD

Date Received:	06-09-98	Matrix:	Water
Date Extracted:	06-10-98	Sample amount:	1000mL:2mL
Date Analyzed:	06-11-98		
Instrument ID:	GC #13	Units:	ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	1.1	0.02
Dibutyltin	14	0.02
Tributyltin	0.18	0.04
Tetrabutyltin	ND	0.02

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	79	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

Sample: 498324-C1-#2

Organotins by GC/FPD

Date Received:	06-09-98	Matrix:	Water
Date Extracted:	06-10-98	Sample amount:	1000mL:2mL
Date Analyzed:	06-11-98		
Instrument ID:	GC #13	Units:	ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	1.5	0.02
Dibutyltin	11	0.02
Tributyltin	0.10	0.04
Tetrabutyltin	ND	0.02

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	68	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

Sample: 498324-C1-#3

Organotins by GC/FPD

Date Received:	06-09-98	Matrix:	Water
Date Extracted:	06-10-98	Sample amount:	1000mL:2mL
Date Analyzed:	06-11-98		
Instrument ID:	GC #13	Units:	ug/L (ppb)

Compound	Concentration	Detection Limit
Monobutyltin	ND	0.02
Dibutyltin	ND	0.02
Tributyltin	ND	0.04
Tetrabutyltin	0.32	0.02

Surrogate	Percent Recovery	Control Limits
Tetrapropyltin	93	50-150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

Organotins by GC/FPD

Matrix Spike/Matrix Spike Duplicate Recovery Summary

QC Batch: BATCH QC
Date Analyzed: 06-04-98

Matrix: Water
Date Extracted: 06-04-98
Units: ppb

Analyte	Sample Result	Amount Spiked	MS Result	% Rec MS	MSD Result	% Rec MSD	RPD
MBT	ND	1.4	0.106	8	0.138	10	26
DBT	ND	1.65	0.82	50	1.09	66	28
TBT	ND	1.41	1.2	85	1.4	99	15
TeBT	ND	1.31	1.038	79	1.07	82	3

QC Limits

Analyte	RPD Control	% Recovery Control	
Monobutyltin	35	0	100
Dibutyltin	35	30	110
Tributyltin	35	50	150
Tetrabutyltin	35	50	150

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

GCMS Volatile Screen for Organic Constituents

Sample Preparation

5mL of the samples were each loaded into individual purge vessels. Internal standards and surrogates (Bromochloromethane, 1,4-Difluorobenzene, Chlorobenzene-d5, 1,2-Dichloroethane-d4, Toluene-d8, and Bromofluorobenzene) were then spiked into the purge vessel. The samples were analyzed by purge and trap GC/MS. The results are given on the next page.

GC/MS Conditions

GC Column:	25m x 0.20mm HP-624, 1.12 micron film (Hewlett Packard)
GC Conditions:	35°C (hold 4 min), program to 200°C at 8°C/min, then hold for 1.87 min.
Injector:	220°C
Scan Range:	35-300 amu, 2.78 scans/second

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WEST COAST ANALYTICAL SERVICE, INC.

THOMAS REID ASSOCIATES
Attn: Thomas Reid

Job No: 38369
June 15, 1998

LABORATORY REPORT

GCMS Volatile Screen for Organic Constituents *

Sample: 498324-Cl-#4

Compound	Concentration	Detection Limit
Acetone **	20	5
Chloroform **	63	1
Bromodichloromethane **	2	1

Units: ug/l (ppb)

Sample: 498324-Cl-#5

Compound	Concentration	Detection Limit
Acetone **	97	5
Chloroform **	45	1
Bromodichloromethane **	1	1
Ethanol	40	5
Diethyl ether	5	5
Isopropyl Alcohol	10	5

Units: ug/l (ppb)

Date analyzed: 6/12/98

* - The GCMS screen is designed to be qualitative and semi-quantitative. There may be other components in the sample which were too volatile, non-volatile, or thermally labile to be detected. The values have also not been corrected for different component responses, therefore the results are only semi-quantitative estimates. More accurate quantitation may be obtained through additional analysis using standards.

** - Results are quantitated using a standard.

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Abbreviations Summary

General Reporting Abbreviations:

B — Blank - Indicates that the compound was found in both the sample and the blank. The sample value is reported without blank subtraction. If the sample value is less than 10X the blank value times the sample dilution factor, the compound may be present as a laboratory contaminant.

D — Indicates that the sample was diluted, and consequently the surrogates were too dilute to accurately measure.

DL — Detection Limit - Is the minimum value which we believe can be detected in the sample with a high degree of confidence, taking into account dilution factors and interferences. The reported detection limits are equal to or greater than Method Detection Limits (MDL) to allow for day to day and instrument to instrument variations in sensitivity.

J — Indicates that the value is an estimate.

ND — Not Detected - Indicates that the compound was not found in the sample at or above the detection limit.

ppm
ppb — Parts per million (billion) in liquids is usually equivalent to mg/l (ug/l), or in solids to mg/kg (ug/kg). In the gas phase it is equivalent to ul/l (ul/m^3).

TR — Trace - Indicates that the compound was observed at a value less than our normal reported Detection Limit (DL), but we feel its presence may be important to you. These values are subject to large errors and low degrees of confidence.

kg	kilogram	mg	milligram	l	liter
g	gram	ug	microgram	ul	microliter
m	meter				

QC Abbreviations:

Control & Warning Limits — QC Limits are determined from historical data. The test value must be within the Control Limits for the test to be considered valid. Based on historical data, the confidence intervals are 95% for warning limits and 99% for control limits.

% Error — Percent Error - This is a measure of accuracy based on the analysis of a Laboratory Control Standard (LCS). An LCS is a reference sample of known value such as an NIST Standard Reference Material (SRM). The % Error is expressed in percent as the difference between the known value and the experimental value, divided by the known value. The LCS may simply be a solution based standard which confirms calibration (ICV or CCV - initial or continuing calibration verification), or it may be a reference sample taken through preparation and analysis.

ANRESCO

INCORPORATED

ANALYSIS RESEARCH CONSULTING

HEADQUARTERS
1370 Van Dyke Ave., San Francisco, CA 94124
Tel: (415) 822-1100 Fax: (415) 822-6615
Toll Free: 800-359-0920

790 Basin Street, #2
San Pedro, California 90731
Tel: (310) 833-4598
Fax: (310) 833-1585

2310 N. W. 55th Court #123 &124
Fort Lauderdale, Florida 33309
Tel: (954) 486-2233
Fax: (954) 486-2886

8 June 1998

File Number: 498324-Cl-#1thru#5

West Coast Analytical Service, Inc.
9840 Alburtis Avenue
Santa Fe Springs, CA 96070
Atn: Eric Lindsay

Re: Analysis for organo-tins & drinking water organics for Thomas Reid Associates
Chlorinated (pH 8 conditioning*) water extractions

Dear Mr. Lindsay:

Please find enclosed five amber glass jars (ca. 1L each) of conditioning water extracts and controls for the Thomas Reid Associates project. Hopefully Mr. Reid has already alerted you to expect these samples and has discussed the required analyses. These samples should be reported directly to Mr. Thomas Reid and not ANRESCO. All billing for this project should go directly to Thomas Reid Associates, not ANRESCO. IF you need clarification, etc. please feel free to contact me at your convenience.

Client Contact: Mr. Thomas Reid (e-mail tra@igc.org)
Thomas Reid Associates
560 Waverly Street, Suite 201 - PO Box 880
Palo Alto, CA 94301 Phone: 650-327-0429 FAX 650-327-4024

Samples being submitted:
498324-Cl-#1 water extract for organo-tin analysis {20.77g CPVC in 968mL) - pH 8.58
498324-Cl-#2 water extract for organotin analysis spiked with 2.4 microgram Plictran - pH 8.79
(tricyclohexyl tin hydroxide, cyhexatin) {20.58g CPVC in 971mL)
498324-Cl-#3 conditioning water blank for organo-tin analysis - pH 8.96
498324-Cl-#4 water extract for organic compounds analysis{22.13g CPVC in 967mL} - pH 9.26
498324-Cl-#5 conditioning water blank for organic compounds analysis - 9.21

Spike was produced using 5 microliters of a solution of 9.6mg Plictran in 20mL acetone.

Best Regards;

E. Jerry Oliveras
Laboratory Director

F:\users\jerry\trawcas598.wpd

*** conditioning water described in attached pages, section 13.5**

DHC

No 38369 6/9/98 12 PM

R

Attachments to Comments from Thomas Reid Associates on the 1998 CPVC EIR

ATTACHMENT R

1998 Testing Results, TRI/Environmental, Inc.

TRI/Environmental, Inc.
Protective Clothing Program

9063 Bee Caves Road
Austin, TX 78733-6201
512 263 2101/800 880 8378
Fax: 512 263 2558

FAX TRANSMISSION COVER SHEET

Date: *June 22, 1998*

To: *Dan Cardozo, Adams, Broadwell & Joseph*

Fax: *650-589-5062*

Re: *Final Permeation Test Results for Oatey Cement & Primer*

Sender: *Laraine Johnston*

YOU SHOULD RECEIVE 10 PAGE(S), INCLUDING THIS COVER SHEET. IF YOU DO NOT RECEIVE ALL THE PAGES, PLEASE CALL 512 263 2101/800 880 8378.

Dear Mr. Cardozo,

Here are the final permeation testing results performed on Safety 4H Glove against Oatey LO-V.O.C. CPVC Cement and Oatey Lo-V.O.C. Purple Primer. The data did not change between preliminary and final states. Our GC technician did have a discussion with Tom Reid about methods and procedures.

I will put a copy of these reports in the mail to you.

Sincerely,

Laraine Johnston

Laraine Johnston
Assistant Program Manager
Protective Clothing Department

Encl.

PERMEATION TEST RESULTS FOR ADAMS BROADWELL & JOSEPH USING SAFETY 4H GLOVE AGAINST OATEY LO-V.O.C. CPVC CEMENT AND OATEY LO-V.O.C. PURPLE PRIMER

JUNE 22, 1998

	OATEY LO-V.O.C. CPVC CEMENT		
CHEMICAL	**Average B/T Time (Min)**	**Average Normalized Breakthrough Time(Min)**	**Average Permeation Rate ($\mu g/cm^2$*min)**
Acetone, 30%	>480	>480	<0.05
Cyclohexanone, 7.5%	>480	>480	<0.05
Methyl Ethyl Ketone, <5%	>320	>470	<0.07
Tetrahydrofuran, 45%	190	>270	0.18

	OATEY LO-V.O.C. PURPLE PRIMER		
CHEMICAL	**Average B/T Time (Min)**	**Average Normalized Breakthrough Time(Min)**	**Average Permeation Rate ($\mu g/cm^2$*min)**
Acetone, 2.5%	>480	>480	<0.05
Cyclohexanone, 14%	>480	>480	<0.05
Methyl Ethyl Ketone, 75%	>480	>480	<0.05
Tetrahydrofuran, 12.5%	>480	>480	<0.05

TRI/ Environmental, Inc.
9063 Bee Caves Road
Austin, TX 78733
Phone : (512) 263-2101

Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T01
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-01
Test Date : 6/11/98

Analyst / QC Date

PERMEATION TEST REPORT
Acetone

Material Name Safety 4H Glove
Conditioning : None
Chemical : Oatey Le-V.O.C. CPVC Cement (Acetone Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 30 %
CAS No. : 67-64-1

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Normalized Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05	<0.05	<0.05	<0.05	NA
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min
+ Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated box tests with excessive breakthrough may reflect maximum rates that are artificially low.

2 ml. 2 ml

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Austin, TX 78733
Phone : (512) 263-2101

Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T01C
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-01
Test Date : 6/11/98

Analyst — QC Date 6/22/98

PERMEATION TEST REPORT
CYCLOHEXANONE

Material Name : Safety 4H Glove
Conditioning : None
Chemical : Oatey Le-V.O.C. CPVC Cement (Cyclohexanone Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 7.5 %
CAS No. : 108-94-1

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Normalized Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05	<0.05	<0.05	<0.05	NA
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min

+ Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated test tests with excessive breakthrough may reflect maximum rates that are artificially low.

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Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T01A
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-01
Test Date : 6/11/98

Analyst QIC Date 6/22/98

PERMEATION TEST REPORT
METHYL ETHYL KETONE

Material Name Safety 4H Glove
Conditioning : None
Chemical : Oatey Lo-V.O.C. CPVC Cement (Methyl Ethyl Ketone Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : <5 %
CAS No. : 78-93-3

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	210	270	>320	NA
Normalized Breakthrough : (time in minutes)	>480	>480	480	>470	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05	0.08	0.10	<0.07	NA
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test, every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min

+ Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warrantes nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated box tests with excessive breakthrough may reflect maximum rates that are artificially low.

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Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T01B
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-01
Test Date : 6/11/98

Analyst QC Date 6/12/98

PERMEATION TEST REPORT
TETRAHYDROFURAN

Material Name Safety 4H Glove
Conditioning : None
Chemical : Oatey Lo-V.O.C. CPVC Cement (Tetrahydrofuran Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 45 . %
CAS No. : 109-99-9

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	330	60	180	190	110
Normalized Breakthrough : (time in minutes)	>480	120	210	>270	NA
Maximum Rate Detected: (ug/cm2*min)	0.07	0.22	0.25	0.18	0.08
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min

+ Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated box tests with excessive breakthrough may reflect maximum rates that are artificially low.

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Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T02
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-02
Test Date : 6/11/98

Analyst QC Date 6/22/98

PERMEATION TEST REPORT
Acetone

Material Name : Safety 4H Glove
Conditioning : None
Chemical : Oatey Lo-V.O.C. Purple Primer (Acetone Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 2.5 %
CAS No. : 67-64-1

TEST RESULTS	CELL 1		CELL 2		CELL 3		Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480		>480		>480		>480	NA
Normalized Breakthrough : (time in minutes)	>480		>480		>480		>480	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05		<0.05		<0.05		<0.05	NA
Unit Area Weight (g/cm2)	0.0074		0.0084		0.0079		0.0079	0.0004
Sample thickness (.001")	3		3		3		3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min

- Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual workplace exposure. Due to the use of a one point calibration curve automated test tests with excessive breakthrough may reflect maximum rates that are artificially low.

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Phone : (512) 263-2101

Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T02C
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-02
Test Date : 6/11/98

Analyst QIC Date 6/12/98

PERMEATION TEST REPORT
CYCLOHEXANONE

Material Name : Safety 4H Glove
Conditioning : None
Chemical : Oatey Lo-V.O.C. Purple Primer (Cyclohexanone Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 14 %
CAS No. : 108-94-1

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Normalized Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05	<0.05	<0.05	<0.05	NA
Unit Area Weight (g/cm2)	0.0074	0.0084	0.0079	0.0079	0.0004
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min
Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve aromatic bar tests with excessive breakthrough may reflect maximum rates that are artificially low.

TRI / Environmental, Inc.
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Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T02A
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-02
Test Date ; 6/11/98

Analyst QC Date 6/12/98

PERMEATION TEST REPORT
METHYL ETHYL KETONE

Material Name Safety 4H Glove
Conditioning : None
Chemical : Oatey Lo-V.O.C. Purple Primer (Methyl Ethyl Ketone Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 75 %
CAS No. : 78-93-3

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Normalized Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05	<0.05	<0.05	<0.05	NA
Unit Area Weight (g/cm2)	0.0074	0.0084	0.0079	0.0079	0.0004
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min
Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated test tests with excessive breakthrough may reflect maximum rates that are artificially low.

TRI / Environmental, Inc.
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Phone : (512) 263-2101

Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : J075T02B
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-02
Test Date : 6/11/98

Analyst QC Date 6/22/98

PERMEATION TEST REPORT
TETRAHYDROFURAN

Material Name Safety 4H Glove
Conditioning : None
Chemical : Oatey Lo-V.O.C. Purple Primer (Tetrahydrofuran Analysis)
Source : Orchard Supply Hardware

Test Temperature : 22 deg. C
Test Duration : 8 Hours
Concentration : 12.5 %
CAS No. : 109-99-9

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Normalized Breakthrough : (time in minutes)	>480	>480	>480	>480	NA
Maximum Rate Detected: (ug/cm2*min)	<0.05	<0.05	<0.05	<0.05	NA
Unit Area Weight (g/cm2)	0.0074	0.0084	0.0079	0.0079	0.0004
Sample thickness (.001")	3	3	3	3	0.0

Modifications of Method : 1" Cells
Analytical Technique : Gas Chromatography
Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration.
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Methanol
Minimum detection limit : 3.75 ppm
Minimum detectable rate : 0.05 ug/cm2*min
+ Notes:

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one ppm calibration curve automated box tests with excessive breakthrough may reflect maximum rates that are artificially low.

TRI/Environmental, Inc.
Protective Clothing Program

9063 Bee Caves Road
Austin, TX 78733-6201
512 263 2101/800 880 8378
Fax: 512 263 2558

FAX TRANSMISSION COVER SHEET

Date: May 14, 1998

To: Dan Cardozo, Adams, Broadwell & Joseph

Fax: 650-589-5062

Re: Permeation Test Reports for IPS Weld-On Plastic Pipe Cement & Plastic Pipe Primer

Sender: Laraine Johnston

YOU SHOULD RECEIVE 7 PAGE(S), INCLUDING THIS COVER SHEET. IF YOU DO NOT RECEIVE ALL THE PAGES, PLEASE CALL 512 263 2101/800 880 8378.

Dear Mr. Cardozo,

I spoke with Tina Hoff of Safety 4 this afternoon, and she asked that I fax these reports to you. I have also enclosed a copy of the MSDS for the pipe cement so that you can determine if its contents are similar to the Oatey brand.

Please let me know if we can provide further information.

Sincerely,

Laraine Johnston

Laraine Johnston
Assistant Program Manager
Protective Clothing Department

Encl.

TRI / Environmental, Inc.
9063 Bee Caves Road
Austin, TX 78733
Phone : (512) 263-2101

Safety 4
9765 Widmor
Lenexa, KS 66215

Filename : J002T01

Method Standard : ASTM F739-96

Material Log No. : 98002-01-03

Test Date : 2/2/98

Analyst

8/4/98
QC Date

PERMEATION TEST REPORT

Material Name 4H Glove

Conditioning : None

Chemical : IPS Weld-On Series 2000 Plastic Pipe Cement

Source : Customer Supplied

Test Temperature : 27 deg. C

Test Duration : 8 Hours

Concentration : 100 %

CAS No. : N/A

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	6	6	3	5	1.4
Normalized Breakthrough : (time in minutes)	9	15	6	10	4
Maximum Detectable Rate : (ug/cm2/min)	6.0	2.8	3.5	4.1	1.4
Unit Area Weight (g/cm2)	0.0084	0.0084	0.0084	0.0084	0
Sample thickness (mils)	3	3	3	3	0

Modifications of Method : 1" Cells

Analytical Technique : Continuous Photo Ionization Lamp 10.2

Sampling Frequency : 3 Minutes

Chemical physical state : Liquid

Type of chemical contact : Continuous

Collection medium : Nitrogen

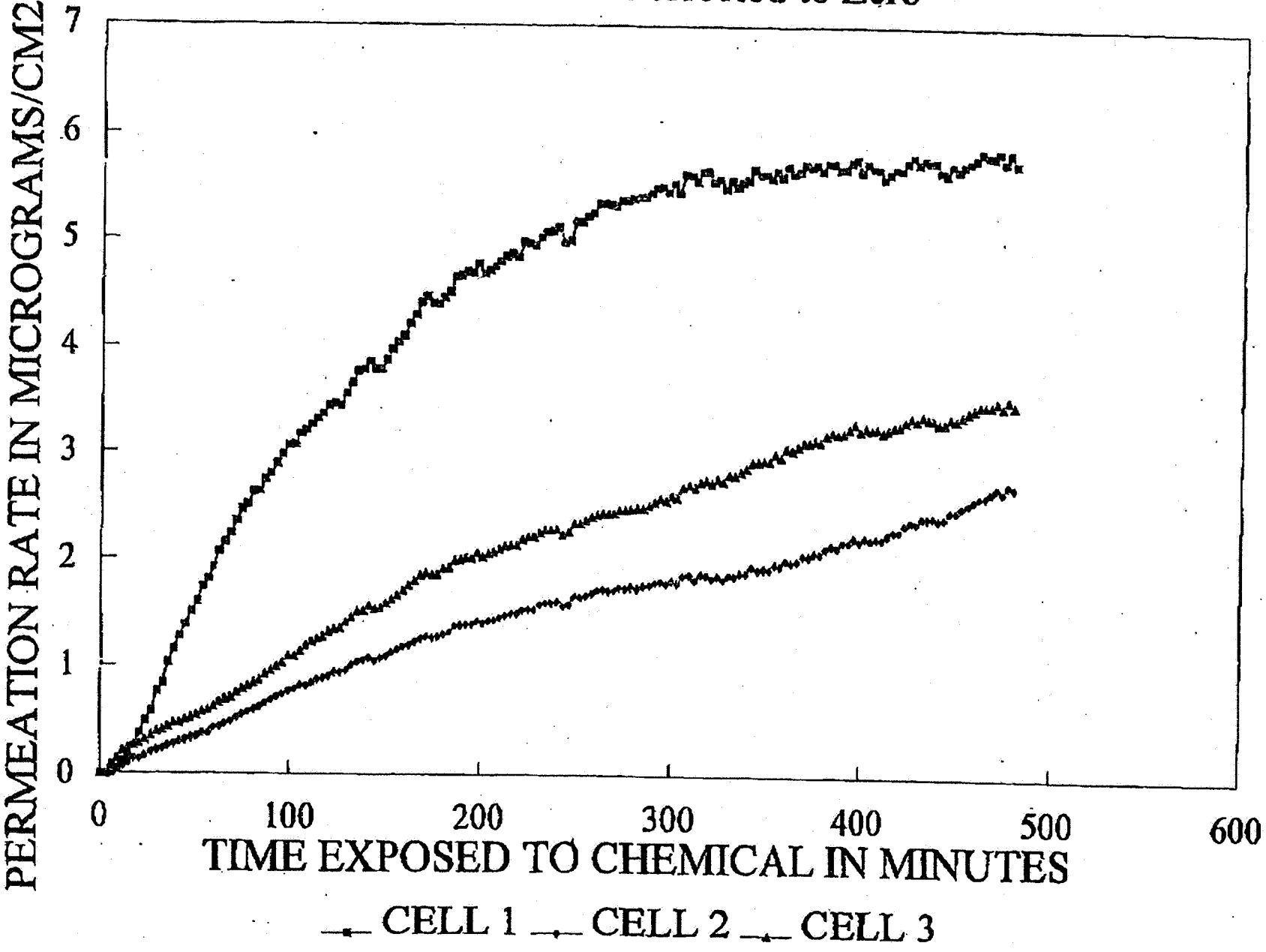
Minimum detection limit : 0.2 ppm

Minimum detectable rate : 0.02 ug/cm2*min

This data was derived from testing performed in accordance with ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warrants nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure.

PERMEATION TEST ASTM 739-96

J002T01 Corrected to Zero



TRI / Environmental, Inc.
9063 Bee Caves Road
Austin, TX 78733
Phone : (512) 263-2101

Safety 4
9765 Widmer
Lenexa, KS 66215

Filename : J002T02
Method Standard : ASTM F739-96
Material Log No. : 98002-01-01
Test Date : 2/3/98

Analyst
QC Date 3/4/98

PERMEATION TEST REPORT

Material Name 4H Glove
Conditioning : None
Chemical : IPS Weld-On Plastic Pipe Primer
Source : Customer Supplied

Test Temperature : 27 deg. C
Test Duration : 8 Hours
Concentration : 100 %
CAS No. : N/A

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	< 3	< 3	< 3	< 3	N/A
Normalized Breakthrough : (time in minutes)	9	< 3	9	< 7	N/A
Maximum Detectable Rate : (ug/cm2/min)	6.8	6.8	22.8	12.8	7.1
Unit Area Weight (g/cm2)	0.0079	0.0084	0.0084	0.0082	0.0000
Sample thickness (mils)	3	3	3	3	0

Modifications of Method : 1" Cells
Analytical Technique : Continuous Photo Ionization Lamp 10.2
Sampling Frequency : 3 Minutes
Chemical physical state : Liquid
Type of chemical contact : Continuous
Collection medium : Nitrogen
Minimum detection limit : 0.2 ppm
Minimum detectable rate : 0.02 ug/cm2*min
Note: Analyzed using the standard for Tetrahydrofuran.

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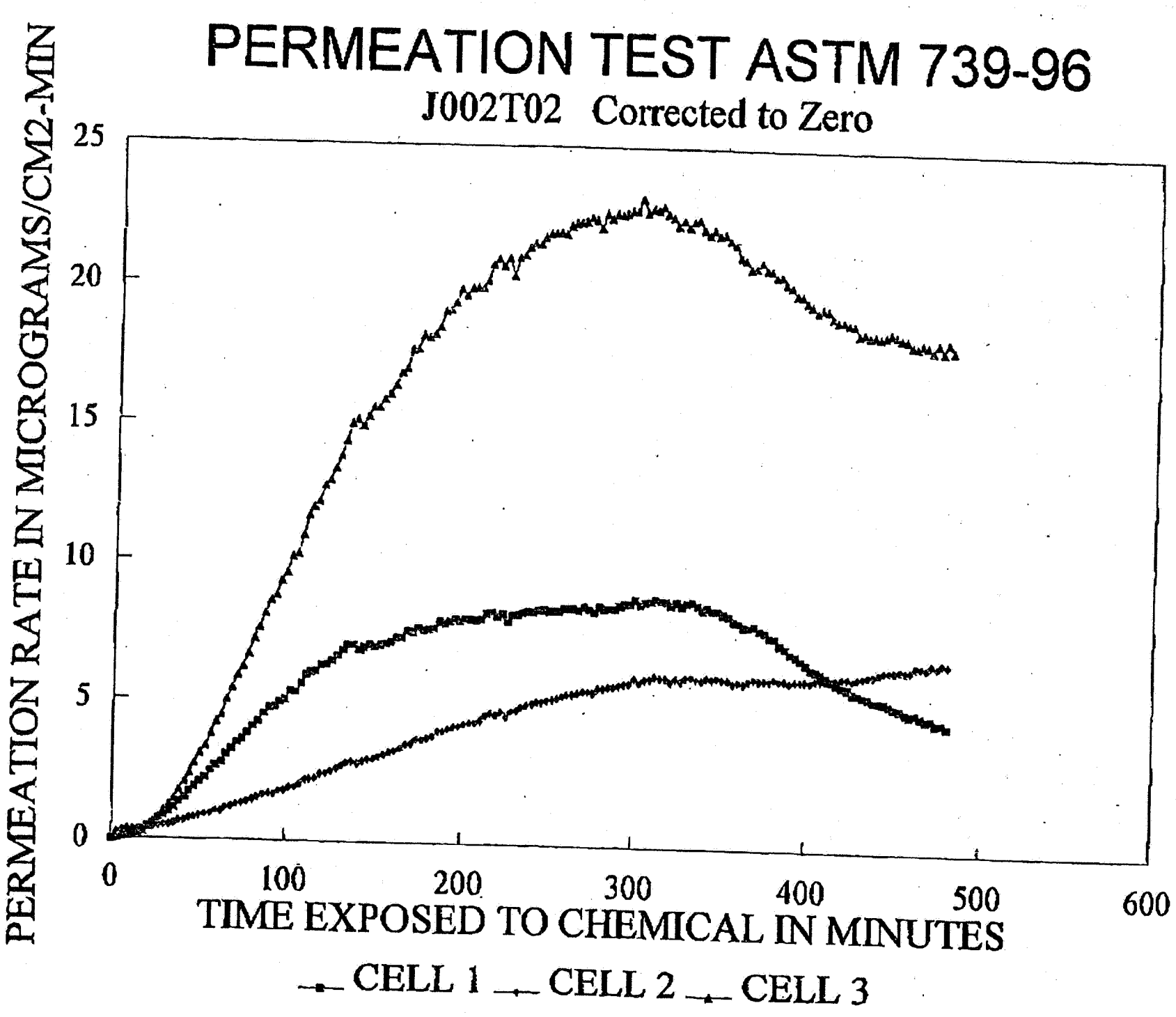
PERMEATION TEST ASTM 739-96
J002T02 Corrected to Zero
PERMEATION RATE IN MICROGRAMS/CM2-MIN
25
20
15
10
5
0
0
100
200
300
400
500
600
TIME EXPOSED TO CHEMICAL IN MINUTES
CELL 1
CELL 2
CELL 3

GLUE 1 of 2

IPS
WELD-ON

MATERIAL SAFETY DATA SHEET

Date Revised: AUG 1995
Supersedes: DEC 1993

Information on this form is furnished solely for the purpose of compliance with the Occupational Safety and Health Act and shall not be used for any other purpose. IPS Corporation urges the customers receiving this Material Safety Data Sheet to study it carefully to become aware of the hazards, if any, of the product involved. In the interest of safety, you should notify your employees, agents and contractors of the information on this sheet.

SECTION I

MANUFACTURER'S NAME
IPS Corporation
ADDRESS
17109 S. Main St., P.O. Box 379, Gardena, CA. 90248

Transportation Emergencies:
CHEMTREC: (800) 424-9300
Medical Emergencies: (213) 222-3212
(L.A. Poison Center 24 Hour No.)
Business: (310) 366-1566

CHEMICAL NAME and FAMILY
Mixture of PVC Resin and Organic Solvents

TRADE NAME:
WELD-ON 2721 Low VOC PVC Plastic Pipe Cement
FORMULA: Proprietary

SECTION II - HAZARDOUS INGREDIENTS

Name of the ingredients below are listed as carcinogens by IARC, NTP or OSHA

	CAS#	APPROX %	ACGIH-TLV	ACGIH-STEL	OSHA-PEL	OSHA-STEL
Polyvinyl Chloride Resin (PVC)	NONHAZ		N/A		N/A	
Tetrahydrofuran (THF)	109-99-9		200 PPM	250 PPM	200 PPM	250 PPM
Methyl Ethyl Ketone (MEK)	78-93-3	16*	200 PPM	300 PPM	200 PPM	300 PPM
Cyclohexanone	108-94-1		25 PPM Skin		25 PPM Skin	
N-Methylpyrrolidone	872-50-4	6*	N/E		N/E	

* Title III Section 313 Supplier Notification: This product contains toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 and of 40CFR372. This information must be included in all MSDS's that are copied and distributed for this material.

SHIPPING INFORMATION FOR GALLON CONTAINERS OR ABOVE

DOT Shipping Name:	Adhesive
DOT Hazard Class:	3
Identification Number:	UN 1133
Packaging Group:	II
Label Required:	Flammable Liquid

SHIPPING INFORMATION FOR CONTAINERS LESS THAN ONE GALLON

DOT Shipping Name:	Consumer Commodity
DOT Hazard Class:	ORM-D

SPECIAL HAZARD DESIGNATIONS

	HMIS	NFPA	HAZARD RATING
HEALTH:	2	2	0 - MINIMAL
FLAMMABILITY:	3	3	1 - SLIGHT
REACTIVITY:	0	1	2 - MODERATE
PROTECTIVE EQUIPMENT:	H		3 - SERIOUS
			4 - SEVERE

SECTION III - PHYSICAL DATA

APPEARANCE
Blue, medium syrupy liquid

ODOR
Ethereal

BOILING POINT (°F/°C)
151°F Based on first boiling component: THF

SPECIFIC GRAVITY @ 73 ± 2°F
Typical 0.990 ± 0.040

VAPOR PRESSURE (mm Hg.)
143 mm Hg. based on first boiling component, THF @ 20°C

PERCENT VOLATILE BY VOLUME (%)
Approx: 65 - 75 %

VAPOR DENSITY (Air = 1)
2.49

EVAPORATION RATE (BUAC = 1)
> 1.0

SOLUBILITY IN WATER
Solvent portion completely soluble in water. Resin portion separates out.

VOC STATEMENT: VOC as manufactured: 720 Grams/Liter. Maximum VOC emission per SCAQMD Rule 1168, Test Method 316A: 450 Grams/Liter.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT
°F T.C.C. Based on THF

FLAMMABLE LIMITS (PERCENT BY VOLUME)	LEL	UEL
	2.0	11.8

FIRE EXTINGUISHING MEDIA
Ansul "Purple K" potassium bicarbonate dry chemical, carbon dioxide, National Aer-O-Foam universal alcohol resistant foam, water spray.

SPECIAL FIRE FIGHTING PROCEDURES
Evacuate enclosed areas, stay upwind. Close or confined quarters require self-contained breathing apparatus, positive pressure hose masks or airline masks, as water spray to cool containers. to flush spills from source of ignition and to disperse vapors.

UNUSUAL FIRE AND EXPLOSION HAZARDS
no hazard because of low flash point and high volatility. Vapors are heavier than air and may travel to source of ignition.

SECTION V - HEALTH HAZARD DATA

PRIMARY ROUTES OF ENTRY: X Inhalation X Skin Contact ___ Eye Contact ___ Ingestion

EFFECT OF OVEREXPOSURE

ACUTE: Inhalation: Severe overexposure may result in nausea, dizziness, headache. Can cause drowsiness, irritation of eyes and nasal passages.
Skin Contact: Skin irritant. Liquid contact may remove natural skin oils resulting in skin irritation. Dermatitis may occur with prolonged contact.
Skin Absorption: Prolonged or widespread exposure may result in the absorption of harmful amounts of material.
Eye Contact: Overexposure may result in severe eye injury with corneal or conjuctival inflammation on contact with the liquid. Vapors slightly uncomfortable.
Ingestion: Moderately toxic. May cause nausea, vomiting, diarrhea. May cause mental sluggishness.
CHRONIC: Symptoms of respiratory tract irritation and damage to respiratory epithelium were reported in rats exposed to 5000 ppm THF for 90 days. Elevation of SGPT suggests a disturbance in liver function. The NOEL was reported to be 200 ppm.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Individuals with pre-existing diseases of the eyes, skin or respiratory system may have increased susceptibility to the toxicity of excessive exposures.

EMERGENCY AND FIRST AID PROCEDURES

Inhalation: If overcome by vapors, remove to fresh air and if breathing stopped, give artificial respiration. If breathing is difficult, give oxygen. Call physician.
Eye Contact: Flush eyes with plenty of water for 15 minutes and call a physician.
Skin Contact: Remove contaminated clothing and shoes. Wash skin with plenty of soap and water for at least 15 minutes. If irritation develops, get medical attention.
Ingestion: Give 1 or 2 glasses of water or milk. Do not induce vomiting. Call physician or poison control center immediately.

SECTION VI - REACTIVITY

STABILITY			CONDITIONS TO AVOID
	UNSTABLE		Keep away from heat, sparks, open flame and other sources of ignition.
	STABLE	X	

INCOMPATIBILITY (MATERIALS TO AVOID) Caustics, ammonia, inorganic acids, chlorinated compounds, strong oxidizers and isocyanates.

HAZARDOUS DECOMPOSITION PRODUCTS
When forced to burn, this product gives out carbon monoxide, carbon dioxide, hydrogen chloride and smoke.

HAZARDOUS POLYMERIZATION			CONDITIONS TO AVOID
	MAY OCCUR		Keep away from heat, sparks, open flame and other sources of ignition
	WILL NOT OCCUR	X	

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Eliminate all ignition sources. Avoid breathing of vapors. Keep liquid out of eyes. Flush with large amount of water. Contain liquid with sand or earth. Absorb with sand or nonflammable absorbent material and transfer into steel drums for recovery or disposal. Prevent liquid from entering drains.

WASTE DISPOSAL METHOD
Follow local, State and Federal regulations. Consult disposal expert. Can be disposed of by incineration. Excessive quantities should not be permitted to enter drains. Empty containers should be air dried before disposing. Hazardous Waste Code: 214.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)
Atmospheric levels should be maintained below established exposure limits contained in Section II. If airborne concentrations exceed those limits, use of a NIOSH-approved organic vapor cartridge respirator with full face-piece is recommended. The effectiveness of an air purifying respirator is limited. Use it only for a single short-term exposure. For emergency and other conditions where short term exposure guidelines may be exceeded, use an approved positive pressure self-contained breathing apparatus.

VENTILATION
Use only with adequate ventilation. Provide sufficient ventilation in volume and pattern to keep contaminants below applicable exposure limits set forth in Section II. Use only explosion proof ventilation equipment.

PROTECTIVE GLOVES
PVA coated

EYE PROTECTION
Splashproof chemical goggles

OTHER PROTECTIVE EQUIPMENT AND HYGIENIC PRACTICES
Impervious apron and a source of running water to flush or wash the eyes and skin in case of contact.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Store in the shade between 40°F - 110°F. Keep away from heat, sparks, open flame and other sources of ignition. Avoid prolonged breathing of vapor. Use with adequate ventilation. Avoid contact with eyes, skin and clothing. Train employees on all special handling procedures before they work with this product.

OTHER PRECAUTIONS
Follow all precautionary information given on container label, product bulletins and our solvent cementing literature. All handling equipment should be electrically grounded.

The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of this data or the results to be obtained from the use thereof.

Prepared by George Blanco of IPS

THF page

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

Sent By Fax To 650-589-5062

August 12, 1998

Mr. Daniel Cardozo
Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Dear Mr. Cardozo:

Enclosed are properly signed test reports for Oatey CPVC Cement and Primer analyzed by Photo Ionization Detector, a table listing the component parts of the last sample we took at the end of test, which was analyzed by Gas Chromatography, and a table comparing the constituent parts of two brands of cement and primer. I believe that Jeff Krueger faxed you preliminary data and the CPVC comparison table on Friday.

I will put a copy of the reports and the tables in the mail to you, along with a copy of the invoice. Please call if you have any questions, and thanks for letting us be of service to you.

Sincerely,

Laraine Johnston
Assistant Program Manager
Protective Clothing Department

Encl.

9063 Bee Caves Road • Austin, TX 78733-6201 • (512) 263-2101 • FAX 263-2558 • 1-800-880-T-E-S-T

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9063 Bee Caves Road
Austin, TX 78733
Phone : (512) 263-2101

Adams Broadwell & Joseph
651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : Saf4Cmnt
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-01
Test Date : 7/29/98

Analyst Date 8/1/98

PERMEATION TEST REPORT

rial Name Safety 4H Glove
nditioning : None
nical : Oatey Lo-V.O.C. CPVC Cement+
rce : Orchard Supply Hardware

Test Temperature : 27 deg. C
Test Duration : 8 Hours
Concentration : 100 %
CAS No. : N/A

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : *(time in minutes)*	6	12	99	39	42
Normalized Breakthrough : *(time in minutes)*	9	72	384	155	164
Maximum Rate Detected: *(ug/cm2*min)*	2.4	0.68	0.17	1.1	0.98
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

ifications of Method : 1" Cells
nalytical Technique : PID 10.2 Lamp
npling Frequency : Every 3 minutes
hemical physical state : Liquid
e of chemical contact : Continuous
collection medium : Dehumidified Air
imum detection limit : .11 ppm
Minimum detectable rate : 0.011 ug/cm2*min
Notes: Mixture of chemicals was analyzed using Response Factor for THF aquired 8/7/98

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated test tests with excessive breakthrough may reflect maximum rates that are artificially low.

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651 Gateway Blvd., Ste 900
South San Francisco, CA 94080

Filename : Saf4prim
Method Standard : ASTM F739-96 (Mod.)
Material Log No. : 98075-09-01
Test Date : 7/29/98

Analyst _____ QC _____ Date 8/11/98

PERMEATION TEST REPORT

rial Name Safety 4H Glove
nditioning : None
nical : Oatey Lo-V.O.C. CPVC Primer+
urce : Orchard Supply Hardware

Test Temperature : 27 deg. C
Test Duration : 8 Hours
Concentration : 100 %
CAS No. : N/A

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	N/A	N/A
Normalized Breakthrough : (time in minutes)	>480	>480	>480	N/A	N/A
Maximum Rate Detected: (ug/cm2*min)	<.006	<.006	<.006	N/A	N/A
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

ifications of Method : 1" Cells
nalytical Technique : PID 10.2 Lamp
pling Frequency : Every 3 minutes
hemical physical state : Liquid
e of chemical contact : Continuous
ollection medium : Dehumidified Air
mum detection limit : 0.04 ppm
Minimum detectable rate : 0.004 ug/cm2*min
Notes: Mixture of chemicals was analyzed using Response Factor for THF aquired 8/7/98

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Analyst QC Date 8/11/98

PERMEATION TEST REPORT

rial Name Safety 4H Glove
onditioning : None
nical : Oatey Lo-V.O.C. CPVC Primer+
ource : Orchard Supply Hardware

Test Temperature : 27 deg. C
Test Duration : 8 Hours
Concentration : 100 %
CAS No. : N/A

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	>480	>480	>480	N/A	N/A
Normalized Breakthrough : (time in minutes)	>480	>480	>480	N/A	N/A
Maximum Rate Detected: (ug/cm2*min)	<.006	<.006	<.006	N/A	N/A
Unit Area Weight (g/cm2)	0.0074	0.0079	0.0074	0.0076	0.0002
Sample thickness (.001")	3	3	3	3	0.0

ifications of Method : 1" Cells
nalytical Technique : PID 10.2 Lamp
pling Frequency : Every 3 minutes
hemical physical state : Liquid
e of chemical contact : Continuous
collection medium : Dehumidified Air
mum detection limit : 0.04 ppm
Minimum detectable rate : 0.004 ug/cm2*min
Notes: Mixture of chemicals was analyzed using Response Factor for THF aquired 8/7/98

This data was derived from testing performed in accordance with a modification of ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warranties nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the appropriateness of test conditions when evaluating the suitability of material for actual anticipated exposure. Due to the use of a one point calibration curve automated test tests with excessive breakthrough may reflect maximum rates that are artificially low.

COMPOUNDS PRESENT IN FINAL SAMPLE OF OATEY LO-V.O.C. CPVC CEMENT TEST

August 7, 1998

COMPOUND	Total μg			μg/cm²*min.		
	Cell 1	Cell 2	Cell 3	Cell 1	Cell 2	Cell 3
Tetrahydrofuran	47μg	11μg	<7.5μg	0.62μg	0.14μg	<0.1μg
All Other Compounds	<7.5μg	<7.5μg	<7.5μg	<0.1μg	<0.1μg	<0.1μg

COMPARISON OF COMPOUNDS OF OATEY LO-V.O.C. CPVC CEMENT AND PRIMER TO PS WELD-ON PVC CEMENT AND PRIMER

August 7, 1998

PS Weld-On PVC 2711 Series 2000 Plastic Pipe Cement		Oatey LO-V.O.C. CPVC Cement	
Chemical Component	**Percentage**	**Chemical Component**	**Percentage**
Acetone	<5%	Acetone	20%
Methyl Ethyl Ketone	30%	Methyl Ethyl Ketone	<5%
Tetrahydrofuran	45%	Tetrahydrofuran	60%
Cyclohexanone	25%	Cyclohexanone	10%
PS Weld-On PVC/CPVC P-70 Plastic Pipe Primer		**Oatey LO-V.O.C. Purple Primer**	
Acetone	<5%	Acetone	<5%
Methyl Ethyl Ketone	40%	Methyl Ethyl Ketone	75%
Tetrahydrofuran	50%	Tetrahydrofuran	5%
Cyclohexanone	10%	Cyclohexanone	20%

Based on Gas Chromatography sensitivity rate of <7.5 $\mu g/cm^2$*min. for Tetrahydrofuran and <0.1 $\mu g/cm^2$*min. for all other compounds. Percentages are based on ±2.5%.