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PRELIMINARY SURVEY OF CHEMICAL COMPOSITION, CONTAMINATION, AND ASSOCIATED HEALTH HAZARD OF PLASTIC PIPE FOR POTABLE WATER SUPPLY

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READER'S GUIDE

This study is a preliminary survey of the chemical constituents of plastic pipe, potable water contamination, and the associated health hazard. The study was prepared by Thomas Reid Associates (Palo Alto) under contract to Thomas R. Adams, Adams, Broadwell and Russel attorneys representing Local 467 Plumbers and Steamfitters Union, AFL-CIO. The material is an informational submission to the California Housing and Community Development Commission. The study specifically addresses proposed amendments to the Uniform Plumbing Code (Section 401 (e)).

Five kinds of plastic pipe are being considered for domestic potable water use in residential construction: polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), acrylonitrile-butadiene-styrene (ABS), polyethylene (PE), and polybutylene (PB). Contamination of the water supply by plastic pipe constitutes a health hazard. The purpose of this study is to indicate the scope of the problem which must be considered in order to fully evaluate the degree of the health hazard. In this study we consider the population at large -- the families that will be using water from installed plastic piping systems. We do not consider the hazards of occupational exposure for people installing the plastic piping systems.

Chapter I introduces the philosophy of the study, describes the methods used, and the limitations of the results presented here. The reader is invited to pay particular attention to the limitations. Assessing the hazard of plastic pipe is a complex task and this report is intended only to give an indication of the extent of the problem.

Chapter II describes the range of chemical substances which can be present in pipe applied to domestic water service. This is the starting point of the study: if a substance is present in the pipe, then it may be a contaminant.

Chapter III assesses the likelihood that chemical constituents will actually contaminate the water supply and be communicated to the population at risk. This includes a discussion of the water analyses conducted by Montgomery Laboratories for the Department of Health Services, Hazard Evaluation System (HES).

Chapter IV summarizes information available on the health effects of some of the compounds. This gives an indication of what the impact might be on the population at risk.

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SUMMARY

This report examines the chemicals found in those plastic pipes under consideration by the California Commission on Housing and Community Development for use for potable water supply. Generically, the five types of pipe are acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyethylene (PE), and polybutylene (PB). We consider which chemicals found in the pipe can enter the water supply and the health risks posed by these. Only with a complete understanding of this can a reasonable decision to license these materials be made. At this time, the necessary understanding is seriously deficient and there is no proof that plastic pipe for water supply does not pose an unacceptable public health hazard.

The major findings of our study are as follows:

(1) There is a wide variety of chemical substances present in the five types of plastic pipe. In addition to the polymers ("plastic") making up the bulk of the pipe, there are compounds used in the manufacture of the pipe such as solvents, monomers, plasticizers and stabilizers, as well as impurities and reaction products between other chemicals. Earlier data and a November 1980 analysis of some of the pipe in question by California Analytical Laboratories, Sacramento, show that the impurities include known carcinogens such as chloroform, benzene, acrylonitrile, and styrene, as well as other compounds on the EPA list of priority pollutants.

(2) The James M. Montgomery labs report is the only study we know of to date which addresses the question of which substances present in plastic pipe can enter the water supply. Our review of this report supports our conclusion that this single study is not a sufficient basis for a decision to license the five kinds of pipe under consideration. Our conclusion is based on the following definite limitations of this report:

(a) The Montgomery study only examined a previously agreed on list of compounds, selected because they were priority pollutants or known solvents. It was not an attempt to analyze all actual contaminants from plastic pipe in the water. It is dangerous to assume that Montgomery had done an exhaustive analysis of all possible pollutants, when this was not the case.

(b) The Montgomery study only examined two kinds of pipe, PVC and CPVC, each made by a single manufacturer. The results cannot be extrapolated to ABS, PE or PB pipe, or even PVC and CPVC pipe made by other manufacturers. A review of plastics literature and a search of U.S. patents revealed that the manufacturing processes of different pipe fabricators can be quite different, and that the same manufacturer can change its process from time to time. A different process or a different kind of pipe means that different amounts and different types of chemicals have the potential to contaminate the drinking water supply. Obviously, the Montgomery study only shows the potential risk from the pipes it examined.

(c) The Montgomery results themselves do not allow reliable statistical inference that there is any method of pre-treating the pipe before use (ie. flushing) which will reduce the public health hazard from chemical contaminants. Although flushing is an intuitively attractive idea, there is no data to prove it effective or to show how long flushing is required.

(d) Among the problems encountered in the Montgomery tests were the problem of resolving too many compounds, high levels of solvent interference with compounds of interest, presumably a large residual set of unanalyzed material, and too few replicates of individual tests.

The Montgomery study is an adequate first attempt at a very difficult technical problem, but its results are preliminary in the extreme. Only a large-scale study of water contamination from all types of pipe would support the decision at hand. If any conclusion is to be drawn from the Montgomery data, it must be conservative; that is, the data presented show at least some high values for each contaminant in the water and these should be considered in interpreting the health hazard of the system.

(3) The population at risk exposed to the subatances in the pipes will be all of the occupants of new homes outfitted with this material. This population will ultimately comprise millions of persons of all ages and both sexes. Among the population at risk will be individuals with high sensitivity to toxic, carcinogenic, mutagenic, and teratogenic substances, such as young children or pregnant women. They will be exposed to these compounds through drinking water, cooking water, bathing and even laundry. While the government tries to protect the health of these sensitive individuals, as with careful control of drugs, the dose of chemicals they would receive from the plastic pipe would be uncontrolled and unregulated.

(4) In addition to a human health risk there is a definite risk to the environment from the waste discharge of water flowing through plastic pipes. The subject chemicals will add to the existing load of pollutants known to have serious environmental effects because they display all of the characteristics of such chemicals. Namely, they are toxic or carcinogenic, are selectively partitioned into and accumulated in living organisms and food chains, are persistent (long half-lives) and may be widely dispersed in the environment.

The conservative levels of carcinogens and other toxins found in the Montgomery study are tens to hundreds of times greater than the EPA "acceptable risk levels" (1 cancer in 1 million persons exposed). At best, the licensing of plastic pipe for potable water will expose a large population to long term, low-level, chronic toxicity of unknown danger. At present, the data concerning chemicals in the pipe, the levels entering the water supply over time, time population health effects, and the environmental effects are incomplete and inconclusive. What evidence there is indicates that the chemicals present a potentially serious risk. In the absence of conclusive information to the contrary, a blanket decision to license PVC, CPVC, ABS, polyethylene and polybutylene pipe for domestic water supply cannot reasonably be supported.

TABLE IV-2

LIKELIHOOD OF CONTAMINATION BY FORMALLY RECOGNIZED CARCINOGENS

Compounds	Expected (used in mfg)	Found in Pipe[4]	Found in Water[5]
OSHA list of Carcinogens[1]			
2-Acetylaminofluorine			
4-Aminobiphenyl			
Benzidine			
3,3'-Dichlorobenzidine			
4'-Dimethylaminoazobenzene			
alpha-Naphthylamine			
beta-Naphthylamine			
4-Nitrobiphenyl			
N-Nitrosodimethylamine			
beta-Propiolactone			
bis-(chloromethyl)ether			
Chloromethyl methyl ether			
4,4'-Methylene-bis(2-chloroaniline)			
Ethyleneimine			
Asbestos[2]			
Benzene[2]		Y	Y
Coal tar volatiles - coke oven emissions[2]			
Vinyl chloride[2]	Y		
Strong Carcinogens[2]			
Benz(a)pyrene			
2,4-Diaminotoluene			
Dimethylcarbamoyl chloride			
1,1-Dimethylhydrazine (and salts)			
Dimethyl sulfate			
Hexamethylphosphoramide			
Hydrazine (and salts)			
N-(2-Hydroxyethyl)ethyleneimine			
Methylhydrazine (and salts)			
2-Nitronaphthalene			
Nitrosoamines	Y	?	Y
Propane sultone			
Propyleneimine			
Experimental Carcinogens[2]			
Acrilonitrile	Y	Y	?
3-Amino-1,2,4-triazole			
Carbon tetrachloride		Y	Y
Chloroform	Y	Y	Y
1,4-Dichloro-2-butene			
Dioxane			
Epichlorohydrin			
Ethylene dibromide			
Ethylenethiourea			
Lead chromate			
Methylenedianiline			
Styrene	Y	Y	?

APPENDIX A -- KNOWN PLASTIC CONSTITUENTS AND COMMERCIAL ADDITIVES

The polymer industry makes use of hundreds of chemicals in manufacture of commercial plastics. The following pages list several classes of additives to illustrate the range of substances that may be in plastic pipe. The significance is twofold: 1) these substances complicate the analytical problem of analysing what is in a pipe sample or in water from a pipe, and 2) these substances may not have been subject to adaquate toxicological screening.

The lists are taken from T.R. Crompton Chemical Analysis of Additives in Plastics 2nd edition, 1977 Pergamon Press, New York.

Antioxidants

1 Topanol A	2,4-Dimethyl-6-t-butylphenol
2 Topanol OC	2,6-Di-t-butyl-4-methylphenol
3 Tenox BHA	Mixture of 2- and 3-t-butyl-4-hydroxyanisole
4 Binox M	Bis(3,5-di-t-butyl-4-hydroxyphenyl) methane
5 Ionox 330	1,3,5-Trimethyl-2,4,6-tris-(3,5-di-t-butyl-4-hydroxybenzyl)benzene
6 Nonox WSP	Bis(2-hydroxy-3-α-methyl-cyclohexyl-5-methylphenyl)-methane
7 Nonox WSL	2,4-Dimethyl-6-α-methyl-cyclohexyl-phenol
8 Nonox DCP	2,2-Bis(3-methyl-4-hydroxyphenyl) propane
9 Calco 2246	Bis(2-hydroxy-3-t-butyl-5-methyl-phenyl)methane
10 Topanol CA	1,1,3-Tris(2-methyl-4-hydroxy-5-t-butylphenyl)-methane
11 Santonox R	Bis(2-methyl-4-hydroxy-5-t-butylphenyl) sulphide
12 Topanol TP	Bis(2-hydroxy-3,5-di-t-butyl-6-methylphenyl)-sulphide
13 Suconox 18	N-Stearoyl-p-aminophenol
14 Naugawhite	Bis(2-hydroxy-3-nonyl-5-methyl-phenyl)methane
15 Agerite Superlite	-
16 Voidox 100%	2,6-Di-t-butyl-4-methyl phenol + sorbitan/fatty acid compound
17 Irganox 1010	Pentaerythritol-tetra-β-(3,5-di-t-butyl-4-hydroxy-phenyl)propionate
18 Irganox 1076	n-Octadecyl-β-(3,5-di-t-butyl-4-hydroxyphenyl)-propionate
19 Irganox 1093	Di-n-octadecyl-3,5-di-t-butyl-4-hydroxybenzyl phosphonate
20 Polygard	Tris(nonylphenyl) -phosphite
21 Nonox CI	N,N'-Di-β-naphthyl-p-phenylenediamine
22 DLTDP	Dilaurylthiodipropionate
23 Salol	Phenylsalicylate
24 Cyasorb UV9	2-Hydroxy-4-methoxybenxophenone
25 Cyasorb UV 531	2-Hydroxy-4-n-octoxybenzophenone
26 Uvinol 400	2,4-Dihydroybenzophenone
27 Cyasorb UV 24	2,2'-Dihydroxy-4-methoxybenzophenone
28 Tinuvin P	2-(2'-Hydroxy-5'-methylphenyl)-benzotriazole
29 Tinuvin 326	2-(2'-Hydroxy-5'-t-butylphenyl)-3-chlorobenzotriazole
AgeRite Alba	Hydroquinone monobenzyl ether
AgeRite Spar	Styrenated phenol
AgeRite Superlite	A polyalkyl polyphenol
Antioxidant 5	Not disclosed
Antioxidant 425	2,2'-Methylene-bis (6-tert-butyl-4-methylphenol)
Antioxidant 2246	2,2'-Methylenebis (6-tert-butyl-4-methylphenol)
Deenax	2,6,Di-tert-butyl-*p*-cresol
Ionol	2,6-Di-tert-butyl-*p*-cresol
1-Naphthol	1-Naphthol
2-Naphthol	2-Naphthol
Naugawhite	Alkylated phenol
Nevastain A	Not disclosed
Nevastain B	Not disclosed
Nonyl phenol	Nonyl phenol
p-Phenyl phenol	*p*-Phenyl phenol
Polygard	Tris (nonylated phenyl) phosphite
Santovar A	2,5-Di-tert-amyl-hydroquinone
Santovar O	2,5-Di-tert-butyl-hydroquinone
Santowhite Crystals	4,4'-Thio-bis (6-tert-butyl-2-methylphenol)
Santowhite MK	Reaction product of 6-tert-butyl-*m*-cresol and SCl_2
Santowhite Powder	4,4'-Butylidane-bis (3-methyl-6-tert-butylphenol)
Solux	*N-p-Hydroxyphenyl-*morpholine
Stabilite white powder	Not disclosed
Styphen 1	Styrenated phenol
Wingstay S	Styrenated phenol
Wingstay T	A hindered phenol