federal register

Friday
March 23, 1984

Part III

# Environmental Protection Agency

**40 CFR Part 761**
**Polychlorinated Biphenyls (PCBs); Manufacture, Processing, Distribution in Commerce and Use Prohibitions; Use in Electrical Transformers; Advanced Notice of Proposed Rulemaking**

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ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 761

[OPTS 62035; TSH-FRL 2628-7]

Polychlorinated Biphenyls (PCBs); Manufacture, Processing, Distribution in Commerce and Use Prohibitions; Use in Electrical Transformers

AGENCY: Environmental Protection Agency (EPA)

ACTION: Advance notice of proposed rulemaking

SUMMARY: EPA issued a final rule which was published in the Federal Register of August 25, 1982 (47 FR 37342) that, among other provisions, authorized the indefinite use of certain electrical transformers containing polychlorinated biphenyls (PCBs) (PCB Electrical Use Rule). Although EPA had knowledge prior to August 25, 1982 of a major fire-related incident in Binghamton, New York involving a PCB-Transformer, EPA believed that fires involving this equipment were rare, isolated incidents. Thus, EPA did not consider the risks posed from fires when EPA made its determination that the continued use of electrical transformers containing PCBs did not pose unreasonable risks to public health or the environment.

Recent information from a May 1983 fire-related incident in San Francisco, California involving a PCB-Transformer and a September 1983 fire-related event in Chicago, Illinois involving a PCB-Transformer has brought into question EPA's earlier assumption that fire-related events involving PCB-Transformers are rare and isolated occurrences.

The purpose of issuing this Advance Notice of Proposed Rulemaking (ANPR) are to solicit data specific to the risks posed by fires involving electrical transformers that contain PCBs and to solicit data on mechanisms for mitigating or eliminating these risks. Depending upon the results of EPA's analysis of these data, EPA may propose further control measures on the use of this equipment by October 1984.

DATES: Comments on the issues raised in this Notice must be submitted by May 22, 1984.

ADDRESSES: Comments should be submitted in triplicate to TSCA Public Information Office (TS-793), Office of Toxic Substances, Environmental Protection Agency, Rm. E-108, 401 M St., SW., Washington, D.C. 20460.

Comments should include the docket number OPTS-62035. Comments received in connection with this Notice will be available for reviewing and copying from 8:00 a.m. to 4:00 p.m., Monday through Friday, excluding holidays, in Rm. E-107, Environmental Protection Agency, 401 M Street, SW., Washington, D.C.

FOR FURTHER INFORMATION CONTACT: Jack P. McCarthy, Director, TSCA Assistance Office (TS-799), Office of Toxic Substances, Environmental Protection Agency, Rm. E-543, 401 M St., SW., Washington, D.C. 20460. Toll free: (800-424-9065), In Washington, D.C.: (554-1404), Outside the USA: (Operator-202-554-1404).

SUPPLEMENTARY INFORMATION:

## I. Background

Section 6(e) of the Toxic Substances Control Act (TSCA) generally prohibits the use of PCBs after January 1, 1978. The statute does, however, set forth two exceptions under which EPA may, by rule, allow a particular use of PCBs to continue. Under section 6(e)(2) of TSCA, EPA may allow PCBs to be used in a "totally enclosed manner." A "totally enclosed manner" is defined by TSCA to be "any manner which will ensure that any exposure of human beings or the environment to a polychlorinated biphenyl will be insignificant, as determined by the Administrator by rule." TSCA also allows EPA to authorize the use of PCBs in a manner other than a totally enclosed manner if the Agency finds that the use "will not present an unreasonable risk of injury to health or the environment."

EPA promulgated a rule, which was published in the Federal Register of May 31, 1979 (44 FR 31514) to implement sections 6(e) (2) and (3) of TSCA. This rule is listed in the Code of Federal Regulations under 40 CFR Part 761. The rule, among other provisions, designated all intact, nonleaking capacitors, electromagnets, and transformers, other than railroad transformers, as "totally enclosed," thus permitting their use without specific authorizations or conditions. The Environmental Defense Fund (EDF) petitioned the U.S. Court of Appeals for the District of Columbia Circuit to review a number of provisions of the rule, including the portion of the rule that designated all intact and nonleaking capacitors, electromagnets, and transformers as "totally enclosed." (*Environmental Defense Fund, Inc. v. Environmental Protection Agency*, 636 F 2d 1267).

On October 30, 1980, the court, among other things, decided that there was insufficient evidence in the record to support the Agency's classification of transformers, capacitors, and electromagnets as totally enclosed. The court invalidated this portion of the rule, as well as a number of other provisions, and remanded the rule to EPA for further action.

As a consequence of the October 1980 decision, EPA undertook a number of rulemaking actions. The action relevant to the rule which is the subject of today's ANPR was published in the Federal Register of August 25, 1982 (47 FR 37342) (hereafter, PCB Electrical Use Rule). This rule amended the May 31, 1979 rule. The August 1982 amendment, among other provisions, authorized the continued use of PCB-Transformers (electrical transformers containing greater than 500 parts per million (ppm) PCBs) in facilities involved in the handling of food or feed items until October 1, 1985, and, allowed the use of all other categories of non-railroad electrical transformers containing or contaminated with PCBs for the remainder of their useful lives. In its August 25, 1982 decision, EPA made a determination that authorizing the use of these transformers for the remainder of their useful lives did not present an unreasonable risk to public health or the environment for the following reasons:

1. EPA determined that if it did not authorize the use of PCBs in transformers, the costs to the public and United States industry would be billions of dollars, primarily as a result of the disruption of electrical service. EPA determined that the resulting reduction in risk would not outweigh these substantial costs.

2. EPA determined that the inspection and maintenance programs required under the rule reasonably reduced the exposure risks associated with the use of PCBs in PCB Transformers, and the servicing conditions prevented further PCB contamination of transformers.

3. EPA determined that releases of PCBs to the environment and exposure to humans and biological organisms from mineral oil transformers are minimal. EPA estimated that these transformers contain less than 0.15 percent of all the PCBs used in transformers and release less than one-half of a percent of these PCBs on an annual basis.

4. EPA determined that the costs associated with other risk reduction measures such as accelerated phase-out, reducing the PCB concentration in the dielectric fluid, or providing containment for transformers were not reasonable when compared to the potential reduction in releases of PCBs achieved.

In evaluating the risks posed by the continued use of electrical transformers containing PCBs, EPA had considered

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the exposure resulting from leaks and spills of PCB containing dielectric fluid as constituting the principal route of release of PCBs to the environment for this equipment.

There was, however, an indication that fires involving transformers also could be responsible for the release of PCBs. For example, on February 5, 1981, in the Binghamton State Office Building in Binghamton, New York, a PCB-Transformer was involved in a fire in the basement of the building. Monitoring, completed after the fire, indicated the distribution of PCBs, polychlorinated dibenzofurans, and polychlorinated dibenzodioxins throughout the interior of the building. The distribution of PCBs (and suspected oxidation products) throughout the 16-story building occurred via two vertical ventilation shafts that ran the length of the building and opened into the transformer vault in the basement. At the time, however, EPA believed that fires involving transformers that contain PCBs were rare, isolated events. Thus, although EPA made determinations that the use of electrical transformers containing PCBs did not pose unreasonable risks to public health or the environment, EPA did not directly consider the public health and environmental risks posed from fire-related events. EPA also did not evaluate the cost of implementing risk reduction measures to mitigate the risks posed by fires involving this equipment or factor into its economic assessment certain now-identified costs associated with the continued use of these transformers, principally, the high costs of clean-up following these incidents. These costs reduce the benefits associated with the continued use of these transformers.

After promulgation of the 1982 rule, additional information came to EPA's attention that indicated that PCB-Transformer fires may occur more frequently than previously expected, and that PCB-Transformer fire hazards are not restricted solely to transformers located inside buildings. On May 15, 1983, in the One Market Plaza complex in San Francisco, California, a PCB-Transformer was involved in a smoky transformer vault fire. Monitoring completed after the fire indicated the presence of PCBs and polychlorinated dibenzofurans (PCDFs) in soot from this fire. Although the vault housing the transformer was located exterior to the building itself, unsealed conduits from the vault to the basement and outside air intake vents drew the contaminated smoke into the building and allowed for the distribution of the PCBs and polychlorinated dibenzofurans in the ductwork of the building.

The San Francisco incident, and an even more recent incident, in the First National Bank Building in Chicago, Illinois in September 1983, have prompted EPA to consider reassessing its earlier position on the expected frequency of fire-related incidents involving transformers that contain PCBs.

This Advance Notice of Proposed Rulemaking (ANPR) is the Agency's first step in formally assessing the public health and environmental risks posed by fires involving electrical transformers containing PCBs. If EPA determines that the risks posed by fires involving transformers that contain PCBs are sufficiently large, when weighed against the benefits of this equipment and the costs of control measures, then EPA will propose measures by October 1984 to reduce or eliminate these risks.

The purpose of this ANPR, then, is to present certain available information on the risks posed by fires involving transformers that contain PCBs, and, to solicit data in five major areas: (1) The risks posed to human health and the environment in the event of a fire-related accident involving an electrical transformer containing PCBs; (2) the probability of fire-related events occurring that involve electrical transformers that contain PCBs, and factors that may increase this probability; (3) the reactions and mechanisms of reactions involved in the formation of PCDFs and polychlorinated dibenzodioxins (PCDDs) in fire-related incidents involving electrical transformers containing PCBs; (4) the costs and nature of the cost incurred by the owner of a transformer involved in a fire-related event; and (5) the identification of available options for mitigating or eliminating the risks posed by fires involving electrical transformers containing PCBs as well as the costs and benefits associated with those options.

If EPA is not provided with adequate data, especially in the areas of the risks posed in the event of a fire, the probability of these fires occurring, and the costs associated with clean-up following these incidents, EPA will make its regulatory judgments based upon the data set forth in this document. These data indicate that PCB-Transformer fires pose relatively high risks, occur with unknown frequency and can result in relatively high clean-up costs.

## II. Transformer Fire Risks

### A. Case Studies

A primary source of information on the causes of and circumstances surrounding fires involving transformers containing PCBs are data compiled from three PCB-Transformer fires in Binghamton, New York, San Francisco, California; and Chicago, Illinois. In order to understand better the risks posed by the use of this equipment in the event of a fire, EPA has evaluated each of these incidents, and compared the circumstances surrounding each fire in order to determine what factors increased the risks posed from the fire, and what factors, if any, reduced the risks presented by the fire.

EPA assumes that the risks posed by a fire involving a PCB-Transformer are related to the degree of dispersion of toxic chemicals from the transformer into areas where people may be present. Thus, EPA expects that PCB-Transformer fires in buildings or near buildings may pose greater risks than PCB-Transformer fires in locations such as outdoor electrical substations. The Agency further assumes that the greater the dispersion of contaminants within a building, the greater the potential for exposure of humans to these contaminants, and therefore, the higher the risks. EPA has reached certain conclusions about the risks posed by transformer fires, based on these three case studies.

The three incidents discussed below are the three most well-characterized and well-researched incidents that EPA is aware of. EPA is soliciting similar information on other fire-related incidents involving transformers containing PCBs. A partial list of other less well-known and less well-researched incidents that EPA is aware of appears in Unit III B. EPA is soliciting additional information on these incidents, as well as information on other incidents not included on this list.

1. *Binghamton, New York.* At 5:30 a.m. on February 5, 1981, a fire occurred in the switchgear adjacent to a PCB-Transformer in the basement mechanical room of the Binghamton State Office Building. This building is an 18 story office tower that was completed in 1973. Power to the building was supplied by two transformers which contained a coolant fluid consisting of 65 percent PCB (trade name Aroclor 1254) and 35 percent mixed tri- and tetrachlorinated benzenes.

Although the city fire departments responded within minutes, they did not enter the mechanical room until the power was disconnected to the

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transformers approximately 50 minutes after the fire started. During this period, there was repeated electrical arcing and reports of loud explosions occurring in the mechanical room. Smoke generated by the fire was distributed by convection throughout the building through an open vertical shaft that started in the mechanical room and ran to the penthouse. This concrete block shaft contained the sheet metal duct for the exhaust air from the men's restrooms on all the floors. The shaft was not air tight, and allowed smoke to escape the space between the structural ceiling and the suspended ceiling on each floor of the building. As a result, the entire inside of the building was coated with black soot.

The probable source of the soot was combustion of the materials in the switch gear. The heat of the fire apparently caused a ceramic bushing to crack on one of the transformers, allowing approximately 180 gallons of insulating liquid to drain onto the floor in the vicinity of the fire. Photographs taken shortly after the fire was extinguished showed that the switch gear was completely destroyed, but there was little damage to the transformers. The mechanical room was heavily coated with soot, and puddles of liquid remained on the floor. The heat from the fire was sufficient to damage slightly a structural steel beam that was directly over the switch gear. However, the fire apparently did not spread to any material other than the switch gear itself.

Elevated levels of PCDFs in the soot were reported within a week after the fire. Comprehensive analyses of the soot were performed by Dr. David Stelling of the U.S. Fish and Wildlife Service, Columbia, Missouri, by Dr. Christopher Rappe of the University of Umea in Sweden, and by Dr. Pat O'Keefe of the New York State Department of Health Laboratories. These analyses reported the presence of PCDDs, PCDFs and polychlorinated biphenylenes (PCBPs), although the amounts found varied from sample to sample. Initial analyses of two soot samples by Smith *et al* (Ref. 1) reported the presence of 2.8 and 2.9 ppm 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and 124 and 273 ppm 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF). A more detailed analysis of a homogenized mixture of soot taken from throughout the building and used in animal feeding studies contained 7,200 ppm PCBs and the following concentrations of various homologs of PCDF: tetra-18 ppm, penta-21 ppm, hexa-2 ppm, hepta-3.5 ppm, and octa-0.74 ppm. Analysis of a single soot sample found 597 ppm total tetra-chlorinated dibenzofuran, 48 ppm 2,3,7,8-TCDF, 1.8 ppm total tetra-chlorinated dibenzodioxins, and 1.2 ppm 2,3,7,8-TCDD. Congener specific analysis of a different Binghamton soot sample found 2,3,7,8 substituted constituents to be the most predominant congeners within each of the levels of chlorination of both PCDFs and PCDDs. Additional sampling data on PCB, PCDF and PCDD levels found following the Binghamton fire, as well as additional information on the circumstances surrounding this incident are presented in the Versar report, "Exposure Assessment- Fires Involving PCB Transformers" (Ref. 1).

The Binghamton State Office Building remains closed to normal use. The building has been extensively cleaned by vacuuming and washing to remove the soot. Analysis of air samples, wipe samples from vinyl walls, and bulk samples of sprayed-on ceiling insulation have demonstrated that the ratio of the various toxic constituents is not constant from one matrix to another, and that the vaporization and redeposition processes are causing a gradual redistribution of the material within the building. Estimates of clean-up costs to date are between $15 and $20 million.

2. *San Francisco, California.* Shortly after 11:00 a.m. on May 18, 1983, a fire started in the sub-basement transformer vault of the One Market Plaza office building complex at the corner of Steuart and Mission Streets in San Francisco. The vault contained three transformers that were filled with Arocior 1242 coolant liquid. Heavy black smoke issued from the sidewalk grating adjacent to the building for about three hours until the high voltage power to the transformer was interrupted by the utility. During this three-hour period, there was considerable vibration and loud noises occurring in the vault that were described by reporters at the scene as "explosions." No information is available on the size of the transformers, but it was reported that only one transformer leaked, and that after the fire there were 50 to 60 gallons of liquid in the vault, with the floor and walls of the vault caked with black soot and liquids dripping from the vault ceiling. The liquid remaining in the transformer contained 0.127 ppm tetrachlorodibenzofuran (TCDF) and no detectable tetrachlorodibenzo-p-dioxin (TCDD).

Smoke and soot from the transformer vault contaminated the adjacent switch gear room (through the bus duct) and small areas of the adjacent parking garage and workshop areas (through small cracks in the concrete block vault walls). Some of the heavy smoke issuing from the sidewalk grating was apparently pulled into the building through street level air makeup louvers and into the ventilating fans that supply air through the sub-basement, basement plaza level, and floors 2 through 6 of the Steuart Street office tower. Tests later indicated that the contamination was limited to the basement, the air handling system through floor 6, and the exterior of the building. The upper floors of the Steuart Street Tower receive air from ventilating fans mounted in a penthouse above the 26th floor.

Air samples taken in the vault starting a week after the fire measured 320 to 1500 micrograms per cubic meter PCBs, depending on the rate of ventilation through the vault. (Ambient levels of PCBs in the atmosphere have been measured and range from about 0.1 to 9 nanograms per cubic meter.) The switch gear room adjacent to the vault had air concentrations as high as 96 micrograms per cubic meter before ventilation was started. The San Francisco Department of Public Health restricted access to any area having a level of PCBs in the air in excess of 1 microgram per cubic meter, or surface contamination in excess of 1 microgram PCBs per 100 square centimeters when sampled by wiping with a cloth wetted with octane. Although no samples collected in the offices on floors 2 through 6 were contaminated above these levels, the city requested that the ventilation system not be operated because of the possibility of spreading contamination to these clean areas. Without ventilation, these floors could not be occupied.

Analysis of the soot collected in the transformer vault and in the sub-basement adjacent to the wall of the transformer vault showed the presence of PCBs, TCDFs, and TCDDs. A soot sample taken adjacent to the vault showed the presence of 66,000 ppm PCBs, 28.9 ppm total TCDFs (6.3 ppm 2, 3, 7, 8-TCDF), and 0.324 ppm TCDD (0.058 ppm 2,3,7,8-TCDD). Additional sampling data on PCB, PCDF, and PCDD levels found as a result of the San Francisco fire are presented in the Versar report (Ref. 1).

The available reports on the analytical results from One Market Plaza do not specify the analytical procedures nor, in most cases, the detection limits of the procedures used. However, from a comparison of available information on the contents of the transformer and the amount of fluid spilled, and the levels of contaminants measured, it is apparent that the

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conversion of PCBs to PCDFs occurred with about the same efficiency in both Binghamton and San Francisco.

Estimates of clean-up costs to date (provided by the Pacific Gas and Electric Company) are between $15 and $20 million.

3 *Chicago, Illinois.* On September 28, 1983, a fire occurred in a bus bar between a PCB-Transformer and the switch gear in a transformer vault under the plaza on the same block as the First National Bank Building in Chicago, Illinois. Although power to the transformer was cut after about 10 minutes, smoke continued to issue from the sidewalk grating for about 45 minutes. Inspection of the transformers after the fire was extinguished indicated that one of the four transformers in the vault had leaked approximately 15 gallons of coolant consisting of 65 percent Aroclor and 35 percent chlorinated benzenes. The source of the leak was a small hole in the transformer casing that was possibly caused by electrical arcing.

Significant PCB contamination was limited to the vault, the exhaust air ducts from the vault, and to the exterior surfaces of a small building adjacent to the transformer vent. The highest readings outside the vault and its exhaust system were on a window near the vault (497 micrograms per 100 square centimeters) and on an intake air well grille (752 micrograms per 100 square centimeters) and window (398 micrograms per 100 square centimeters). The transformer vault was adjacent to an underground parking garage and shared a ventilating system with the garage and a small adjacent building; however, none of these areas was heavily contaminated.

The First National Bank Building, about one-half block from the vault, was not contaminated. Although one fiberglass filter on an air intake vent on the fourth floor of the First National Bank Building was found to contain about 90 ppm PCBs, nearby filters did not show high levels. The building was evacuated when smoke was seen coming from a window vent; however, the smoke was later identified as the exhaust from an auxiliary diesel generator that started when power was shut off to the transformers.

No analyses were reported for PCDFs or PCDDs in the soot. A number of wipe samples were collected in the First National Bank Building and from the air supply intake near the transformer, but no PCDFs or PCDDs were found.

The First National Bank Building was evacuated at the time of the fire, but reoccupied the following day. Cleaning was limited to the transformer vault, its exhaust system, and the exterior of the small building next to the vault.

*B. Conclusions Based on Case Studies*

Based upon EPA's evaluation of the circumstances surrounding the Binghamton, New York; San Francisco, California; and Chicago, Illinois fires, EPA believes that fires involving PCB-Transformer present certain risks of exposure of humans and the environment to toxic contaminants such as volatilized PCBs and certain oxidation products of PCBs, including PCDF.

1. *Toxicity of PCBs and oxidation products found in soot.* In earlier rulemakings, EPA has already concluded that, based upon available information, persons exposed to PCBs can develop chloracne; and, that based on animal data, there is a potential for reproductive effects and developmental toxicity as well as oncogenicity in humans exposed to PCBs. Although the effects of chloracne are reversible, EPA does not consider this effect of exposure to PCBs to be insignificant (Ref. 2).

According to the September 12, 1980 Carcinogenic Assessment Group's (CAG's) Risk Assessment on 2,3,7,8-TCDD (Ref 3), guaged by results of toxicity testing in animals for a variety of effects, 2,3,7,8-TCDD is one of the most toxic chemicals known. This substance was found in soot samples taken following the Binghamton and San Francisco transformer fires. $LD_{50}$ values of 2,3,7,8-TCDD range from 0.6 micrograms per kilogram orally for the male guinea pig to 275 micrograms per kilogram dermally for the rabbit, which would classify this compound as supertoxic (Ref. 4). (The scale of acute toxicity ranges from practically nontoxic to supertoxic.) Deaths typically occur about one week or more after treatment. In chronic and acute oral 2,3,7,8-TCDD toxicity studies on several animal species, the liver, thymus, and spleen have consistently been the target organs. Liver damage, including necrotic and degenerative changes, lipid accumulation, and increased liver weight have been observed in mice, rats, and guinea pigs following 2,3,7,8-TCDD treatment. Atrophy of the thymus and spleen has also consistently been found in laboratory animals. Other effects of 2,3,7,8-TCDD ingestion include suppression of reproductive function in rats and disturbances of the hematopoietic system with occasional hemorrhaging in monkeys, rats, and mice (Ref. 3).

There are several cancer bioassay studies of 2,3,7,8-TCDD: (1) A Dow Chemical Company study (Kociba *et al.*, 1978) in male and female Sprague Dawley rats; (2) the Van Miller *et al.* (1977) study in male Sprague Dawley rats; (3) the Toth *et al* (1979) study in Swiss mice; (4) the National Cancer Institute (1980 *a*, *b*) studies in rats and mice; (5) the Pitot *et al* (1980) promotion study in rats; and (6) the Kouri *et al.* (1978) cocarcinogenicity study in mice (Ref. 3).

In summary, according to the September 1980 CAG risk assessment (Ref. 3), carcinogenic responses have been induced in mice and rats at very low doses of 2,3,7,8-TCDD. In addition, 2,3,7,8-TCDD has been shown to be a very potent cancer promoter. These results, together with suggestive evidence in epidemiologic studies, constitute substantial evidence that 2,3,7,8-TCDD is likely to be a human carcinogen. In addition, on the basis of a Dow Chemical Company study on 2,3,7,8-TCDD, it appears that 2,3,7,8-TCDD is a more potent carcinogen than aflatoxin $B_1$, which is one of the most potent carcinogens known (Ref. 3).

Toxicological testing of polychlorinated dibenzofurans (PCDFs) has been more limited than testing of 2,3,7,8-TCDD. However, in a study designed to evaluate the comparative toxicity of PCBs and PCDFs, in rats, PCDFs were found to be more toxic than PCBs (Ref. 5). In particular, the results of this study indicate that PCDFs produced severe toxic effects on hematologic and thymic functions. In rats fed diets containing polychlorinated dibenzofurans, severe reduction in erythrocyte counts, hematocrit, and hemoglobin concentration occurred, and blood smears indicated hemolytic anemia.

Following the Binghamton fire, several researchers completed toxicological testing of soot samples in guinea pigs. Based on these studies using Binghamton State Office Building (BSOB) soot, EPA has concluded that multiple exposures to soot from PCB-Transformer fires have the potential to product toxicity in the thymus, the hematopoietic system, the salivary gland duct epithelial end, possibly, the liver (Ref. 6).

It is worth noting that thymic atrophy, bone marrow depletion, and diminished body weight gain, all effects of the subchronic administration of the BSOB soot have been routinely demonstrated in acute studies in guinea pigs using PCDFs and PCDDs (Ref. 6). In addition, the group of guinea pigs dosed with 231.3 ppm BSOB soot in he subchronic study exhibited symptoms characteristic of acute exposure to 2,3,7,8-TCDD and 2,3,7,8-TCDF which include skeletal muscle degeneration, fatty changes in

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hepatocytes, and degeneration of gastrointestinal tract epithelium (Ref. 6).

One paper stated that the oral $LD_{50}$ of the BSOB soot in guinea pigs is 410 milligrams per kilogram body weight (Ref. 6), which would classify this compound as very toxic (Ref. 4).

2. *Discussion of formation of oxidation products from PCBs.* There is direct evidence of the formation of PCDFs and PCDDs from heating and burning commercial mixtures of PCBs and diluents. The direct evidence is from: (1) Laboratory experiments published in chemical and other literature, and (2) chemical analyses of materials at the sites where fires were known to involve transformers that contained PCBs. PCBs, PCDFs, and PCDDs were all found in some soot specimens from both the Binghamton and San Francisco fires. (PCDFs and PCDDs were not analyzed for in the soot from the Chicago fire.)

Laboratory studies provide the best available information on the conversion of pure PCBs to PCDFs. In these studies, a number of different PCB congeners and mixtures of congeners have been heated and the resulting materials analyzed for all PCDFs and PCDDs. Since a specific PCB compound reacts to form a limited number of PCDFs, the formation of PCDFs involves intramolecular elimination of three kinds of diatomic molecules, with or without some rearrangement of chlorine atoms on the remaining phenyl rings. From the products obtained in the PCB reactions, the diatomic molecules, hydrogen, hydrogen chloride, and chlorine, are formed from one hydrogen and/or chlorine atom in ortho positions on each of the two phenyl rings. The optimum temperature range for the published laboratory experiments was 800°C. Yields of PCDFs are in the percent range from 550°C to 600°C, but drop off to tenths of a percent at 500°C and 650°C.

The description and characterization of the chemical reactions occurring in a fire in which aroclors (or any other commercial mixtures of many PCB compounds) are burned is far more complex than the laboratory experiments. However, the same reactions observed in the laboratory should also occur in fire situations where the reactants and reaction conditions are similar to laboratory reaction conditions. Since the laboratory reaction that results in the formation of PCDFs from PCBs is intramolecular and an elimination, the effect of lower concentrations of PCBs (such as those present in mineral oil transformers) should have a minimal effect on the reaction rate or product yield at a given temperature. That is, the fact that less PCB is present means only that less total PCDF will be formed since low concentrations alone are not expected to have any effect on the reaction rate, mechanism of reaction, or product yield. There also appear to be few factors present in an uncontrolled fire situation which would cause the total destruction of PCBs and PCDFs or which would present other competing reactions to reduce the yield of PCDFs.

An uncontrolled fire of sufficient temperature (about 800°C) to burn materials containing PCBs can result in the formation of PCDFs as large as a percentage of the level of PCBs originally present in the material. Concentrations would vary with the volume of contained combustion gases or constituents of material containing particulate combustion solids. Although high temperature incineration is used to dispose of PCBs in oil, PCDFs and PCDDs have also been detected following the incineration of PCBs in oil. Incineration of PCBs requires at 1200°C temperature, a two-second residence time, and sufficient oxygen. As explained above, however, laboratory experiments indicate that the reaction temperature for the formation of PCDFs is optimized at around 800°C.

Commercial mixtures of PCBs frequently contain mixtures of chlorobenzenes as well as PCBs. Even "pure" PCB may have low concentrations of chlorobenzenes present as contaminants. Experiments have shown the formation of PCDFs and PCDDs from pyrolysis of mixtures of chlorobenzenes in air. Other chlorinated compounds including chlorophenols were also formed. Amounts of PCDFs ranged as high as tenths of a percent for mixtures of trichlorobenzenes. Tetra- and pentachloro-benzene mixtures formed amounts of PCDFs and PCDDs which were two orders of magnitude smaller than the amounts of these compounds formed by trichlorobenzene. PCDFs and PCDDs may also be formed from the chlorinated phenols observed in the pyrolysis of chlorinated benzenes. The reactions to form PCDFs and PCDDs are bimolecular and the experimental concentrations of chlorobenzenes were high. The reduced concentration of chlorobenzene as a contaminant in commercial uses of PCBs would probably not lead a substantial increases in the amounts of PCDFs and PCDDs formed from burning or heating the PCBs. The notable exceptions are commercial materials using chlorobenzenes as a solvent for concentrated PCBs, i.e., sakarels. EPA believes that the PCDD levels found in the Binghamton soot samples resulted from the oxidation of chlorobenzenes. The low level PCDDs found following the San Francisco fire could have been associated with the possible presence of low concentrations of chlorobenzenes in the fluid, from past servicing operations. Information is not available on the products resulting from pyrolyzing chlorobenzene in commercial uses of PCBs, at different temperatures, in the range expected to be formed in uncontrolled burning.

With respect to possible burning or heating of commercial PCB mixtures at low concentrations in mineral oil, the flash point and fire point of the oil might increase the chances of having a fire start, and, once an oil fire starts, it is not unexpected that a fire would provide suitable reaction conditions for producing PCDFs and PCDDs (if chlorobenzenes are present) from commercial PCBs. The flash points and fire points of both mineral oil and silicone oil could permit the heating of dissolved or dispersed PCBs to temperatures comparable to the temperatures used in published studies of these reactions. Thus, EPA expects that mineral oil equipment and other types of equipment contaminated with PCBs may also pose certain risks in the event of a fire from the perspective of the formation of toxic pyrolysis products.

Compared to mineral oil, the lower flash point and fire point of silicone oils (a potential substitute fluid for retrofilling PCB Transformers) might reduce the chances of having a fire start. But, once a silicone oil fire starts, it is not unexpected that such a fire would also provide suitable reaction conditions for producing PCDFs and PCDDs (when chlorobenzenes are present) from commercial mixtures of PCBs present in the transformers at low concentrations.

EPA is soliciting information concerning the identification and quantitation of residual chlorinated aromatic hydrocarbons, resulting from exposure to open flame burning of commercial formulations of transformer fluids containing PCBs and other chlorinated aromatic hydrocarbons. EPA is also soliciting information on conditions actually present in transformer locations, other than open flames, that can lead to the formation of residual chlorinated aromatic hydrocarbons. EPA is also soliciting information on substitute fluids and the chemical residues present following burning of these materials.

3. *Populations at risk from PCB-Transformer fires.* From its analysis of the three fires in Binghamton, San Francisco, and Chicago, EPA has

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identified six populations that may be at risk in the event of a fire involving PCB-Transformers. The first group are persons present in a building or possibly in an adjacent building at the time of a fire. The second group are firemen and other emergency response personnel responding to the fire. The third group are onlookers present during the extinguishing of the fire, and the fourth group are persons involved in the clean-up following the fire. The final two groups are persons returning to the building following clean-up, and, persons exposed to equipment, automobiles, etc. that may have been contaminated during the fire.

In addition to these incidents posing certain risks to persons present in or around buildings involved in these fires, EPA believes that these incidents may also pose risks to other populations and to the environment. Specifically, depending upon the location and frequency of these incidents, EPA believes that the discharge of contaminated water (used to contain these fires) containing PCBs, PCDFs, and PCDDs into the water system could pose certain risks to other population groups as well. EPA is specifically soliciting data on the risks posed to humans and the environment from the discharge of water used to contain these fires. EPA solicits information on other potential populations that may be at risk in the event of a fire involving a transformer that contains PCBs.

4. *Potential for exposure to PCBs and oxidation products from fires.* Monitoring for PCBs, PCDFs and/or PCDDs was completed after the February 5, 1981 Binghamton fire, the May 15, 1983 San Francisco fire, and the September 28, 1983 Chicago fire. PCB contamination was found in all three incidents, and PCDFs and PCDDs were identified in soot samples from both the Binghamton and San Francisco fires (see Unit II A. for summary of sampling data).

Sampling data accumulated following the Binghamton fire clearly indicates the potential for exposure to PCBs, PCDFs, and PCDDs by firemen, building occupants, and others in the vicinity of a PCB-Transformer fire. Sampling from the San Francisco fire also supports a determination that PCB-Transformer fires pose certain risks of exposure to PCBs, PCDFs, and PCDDs.

EPA solicits additional data on PCB, PCDF, and PCDD levels measured following PCB-Transformer fires.

5. *Factors that appear to increase risks posed by fires.* From EPA's preliminary analysis, it appears that PCB-Transformer fires may pose high risks when they occur near or inside buildings that when they occur in outdoor locations such as electrical substations. From this preliminary analysis, it also appears that one of the primary factors that contribute to the risks posed by fires involving transformers that contain PCBs in buildings in the presence of ventilation shafts or ductwork in the vicinity of a transformer that is involved in a fire. In both Binghamton and San Francisco, ventilation equipment or ductwork in the vicinity of the transformers significantly contributed to the dispersion of PCBs and certain oxidation products, including PCDD and PCDF into the building.

A second factor that appears to increase the risks posed by fires involving PCB-Transformers is the failure of protective devices such as circuit breakers to interrupt the flow of electricity into a transformer. In both Binghamton and San Francisco, there is evidence that suggests that power continued to be provided to these transformers for some time after the initial malfunction. There is speculation that this factor contributed to the formation of additional toxic pyrolysis products, by creating excess heat and other conditions conducive to the formation of these oxidation products.

A third factor that appears to increase the risks posed by fires involving PCB-Transformers if firemen being unaware that they are responding to a fire involving a PCB-Transformer. In both Binghamton and San Francisco, there is evidence to suggest that the firemen who initially responded to the fires were not aware that PCB-Transformers were involved. Thus, these firemen may not have followed certain precautions that might be considered to be appropriate given the potential risks posed in the course of extinguishing such a fire. For example, filmed accounts of the San Francisco fire indicate that heavy black smoke poured out of the underground sidewalk vault housing the PCB-Transformers. These same filmed accounts indicate that respiratory protection was not used by fireman present above the transformer vault during their response to the fire. Further, these filmed accounts also indicate the presence of several similarly unprotected civilian onlookers in the area during the extinguishing of the fire.

A related factor that may be relavent to the degree of risk posed by fires involving PCB-Transformers is the type of building in which the transformer is located. EPA believes that PCB-Transformer fires in office buildings and shopping malls may pose greater risks to the public, because of the concentration of people normally present in these types of buildings. Fires involving PCB-Transformers at industrial facilities may pose lesser risks, because fewer persons are generally present, and EPA expects that these transformers are often in places that are more open, where any malfunctions would be rapidly identified. EPA solicits comments on the relative risks posed by transformers located in office buildings, shopping malls, hotels and motels versus transformers located in industrial facilities or electrical substations.

Finally, EPA believes that there is one other factor that may increase the risks posed by PCB-Transformer fires. This factor is the lack of knowledge on the part of many persons, including fireman and other emergency response personnel, State and local authorities, and persons occupying these buildings about the potential risks posed in the event of a fire involving transformers that contain PCBs. In Binghamton, San Francisco, and Chicago, little structural damage occurred to the buildings as a result of these fires. For the most part, damage was limited to smoke damage. In these cases, a conscious decision was made by authorities at the scene to analyze for the presence of PCBs and certain oxidation products before allowing re-occupancy. Without this decision on the part of authorities present at the scene of other similar fires, it is possible that these other buildings may have been prematurely re-opened for occupancy.

Part of the reason for this general lack of knowledge about the risks posed in the event of PCB-Transformer fires may be the lack of a coordinated effort to accumulate information on similar fires when they occur. Currently, there is no EPA requirement that fires involving PCB-Transformers be reported to the Agency. EPA solicits comments on the benefits of maintaining an EPA PCB-Transformer Fire Reporting system as well as comments on other mechanisms for informing people of the hazards posed by these incidents.

EPA also solicits information from knowledgeable parties on its analysis of what factors increase the risks posed by fires involving PCB-Transformers as well as comments on other factors present during the Binghamton, San Francisco, and Chicago fires (or other fires) that may have increased the risks posed by these fires.

6. *Factors that appear to have decreased the risks posed by fires.* EPA believes that other factors may exist that, in contrast to the factors listed above, limit the risks posed by PCB-Transformer fires. That is, although the Binghamton and San Francisco fires are

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considered to pose certain risks, both of these incidents had the potential to pose much greater risks. For example, one factor that limited the risks associated with the fires in Binghamton and San Fraocisco was the time of the fires. Both fires occurred during periods when these buildings were, for the most part, unoccupied. In contrast, the Chicago fire in September 1983 occurred in the First National Bank Building during a period of high occupency. However, in this incident, power to the transformer was cut after about ten minutes. In Binghamton and San Francisco, the transformers remained energized for 30 minutes and three hours, respectively.

EPA is soliciting information on other factors that may heve mitigated the risks posed by fires involving PCB-Transformers.

*C Cleon-Up Costs Following PCB Transformer Fires*

Given the well-established toxicity of PCBs, and the presence of materials that are more toxic than PCBs in the soot from a fire involving a PCB-Transformer, owners of PCB-Transformers involved in PCB-Transformer fires have invested up to $20 million each to ensure the safety of persons returning to occupy these buildings. For a full analysis of measures taken as part of the clean-up of the Binghamton fire, see "The Binghamton State Office Building Clean-up, a Progress Report Update, 1983" (Ref. 7), and "Investigation of the Contamination Remaining in the Binghamton State Office Building Following Completion of Preliminary Clean-up, October 20, 1982" (Ref. 6). These costs, for the clean-up and removal of contaminated materials containing PCBs, PCDFs, and PCDDs found after these incidents can be factored into the economic analysis of the benefits of the continued use of PCB-Transformers. Earlier analyses of the benefits of the continued use of these transformers, completed in support of the August 25, 1982 PCB Electrical Use Rule, did not take into consideration the costs of clean-up in the event of a PCB-Transformer fire.

In Unit V of this Notice, EPA has presented preliminary estimates of the costs of clean-up in combination with estimates of the probability of such an occurrence, and preliminary estimates of the costs of various control measures designed to mitigate or eliminate the risks posed by PCB-Transformer fires.

## III. Probability of Fires Occurring Involving Transformers That Contain PCBs

*A. The Number and Location of Transformers Containing PCB's*

1. *Data contained in the August 25, 1982 rulemaking record.* Transformers are used extensively by electric utilities and other industries to transmit and distribute electric power efficiently. Some transformers designed for use with PCBs contain between 60 and 70 percent PCBs; others, designed to contain mineral oil dielectric fluid are contaminated with PCBs from past servicing and manufacturing activities.

An estimate of the number of utility owned PCB-Transformers was previously provided to EPA via an Edison Electric Institute and Utilities and Solid Waste Advisory Group (EEI/USWAG) survey of the utility industry. These data were presented in tabular form in the Proposed PCB Electrical Use Rule, published in the Federal Register of April 22, 1982 (47 FR 17426). In the August 25, 1982, PCB Electrical Use Rule, EPA used these data, in combination with existing data from an earlier rulemaking to estimate the total number of PCB-Transformers in service and to estimate the distribution of these transformers among utility and non-utility owners.

In the August 25, 1982 PCB Electrical Use Rule, EPA estimated that the utility industry owned approximately 99,000 in-service PCB-Transformers. EPA estimated that 22,400 of these transformers are located in non-substation locations, such as in and around buildings and industrial facilities. The 39,000 transformers represent about one-third of all PCB-Transformers in service. EPA estimated that about 90,000 PCB-Transformers are non-utility owned transformers. EPA also estimated that there are over 20 million mineral oil transformers in the electrical utility industry and about five million in all other applications. These mineral oil transformers may contain relatively low level PCBs (less than 500 ppm PCBs) as a result of contamination from past servicing activities.

2. *New information on PCB-Transformers.* In late September 1983, a major building owner in the United States, the Equitable Life Assurance Society of the United States (Equitable Life Assurance), approached EPA with information on PCB-Transformers present in its buildings. The survey conducted by Equitable Life Assurance indicates that of the over 500 buildings owned by this corporate building owner, approximately 38 sites are serviced by about 277 PCB-Transformers. Fifteen of these sites are office buildings, 13 are shopping malls, 5 are industrial facilities, and 3 are hotels or motels. Over 80 percent of the PCB-Transformers listed in this limited survey are owned by utilities (Ref. 8).

EPA believes that the estimates of the number of in-service PCB-Transformers used in the August 25, 1982 rule are still valid today. However, in order to evaluate fully the hazards posed by fires involving transformers containing PCBs, EPA needs more detailed information on PCB-Transformers. The data needed include data on: (1) The types of buildings in which PCB-Transformers are used, (2) the number of PCB-Transformers used in each building, (3) the ages of the transformers, (4) the ages of the buildings, (5) the location of the PCB-Transformers serving the buildings, and (6) the ownership of the PCB-Transformers. EPA solicits information from other building owners similar to that provided by Equitable Life Assurance, as well as from State and local municipalities.

EPA also solicits information on the costs of requiring PCB-Transformer owners to report to EPA the number and locations of PCB-Transformers.

*B. Results From a Survey of EPA Regional Offices*

In October 1983, EPA conducted a telephone survey of its regional offices across the United States in an attempt to obtain additional information on the frequency of fire-related events involving transformers that contain PCBs (Ref. 10). From this informal survey, EPA learned that in the period from February 1981 through September 1983, there were at least 15 fire-related incidents involving transformers that contained PCBs (this includes the Binghamton fire, the San Francisco fire, and the Chicago fire).

EPA uses the term "fire-related incident or event" because in many cases it is not clear whether an actual fire occurred in the vicinity of the transformer. However, there appears to be a full spectrum of fire-related events that can occur in the vicinity of a transformer. EPA believes that minor arcing with no apparent volatilization of PCBs or formation of oxidation products is at one end of the spectrum and a Binghamton-like event is at the other end of the spectrum. It is not clear whether conditions short of a Binghamton or San Francisco situation can also lead to the volatilization of PCBs and the formation and/or distribution of toxic oxidation products of PCBs. EPA solicits data on what other fire-related conditions, short of the

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conditions present during fires like Binghamton or San Francisco, can also lead to the volatilization of PCBs and the formation and distribution of PCDFs, PCDDs, and other toxic oxidation products.

According to the results of this telephone survey, there were two fire-related incidents in region I (both in Boston, Massachusetts), three incidents in Region II (in New Jersey, Albany, New York, and Binghamton, New York), two incidents in Region IV (in Clearwater and Miami, Florida), one incident in Region V (in Chicago, Illinois), one incident in Region VI (in Corpus Christi, Texas), one incident in Region VII (in Kansas City, Kansas), two incidents in region VIII (in Denver, Colorado), and four incidents in Region IX (in California) (Ref. 10).

Thus, in a two-year period, without any formal EPA mechanism that required the reporting of fires involving transformers containing PCBs, fifteen incidents were reported to EPA regional offices. Detailed information on all of these incidents is not readily available. In many cases, monitoring for the presence and distribution of PCBs and pyrolysis products does not seem to have been undertaken.

The causes of these 15 fire-related incidents are also not always known. When causes were mentioned by survey respondents, they included: (1) Shortages in bus-bars, (2) switchgear malfunctions, (3) electrical shorts or arcing of the transformer, and (4) high voltage cable burning. One of the more disturbing incidents described by one of the regions was a case in which refuse present in the vicinity of a transformer caught fire as a result of sparks from an arcing transformer. The fire itself began in the refuse beneath the transformer, and, it eventually caused the rupture of the transformer casing.

EPA solicits additional data from knowledgeable parties on the circumstances surrounding the fire-related incidents described above. EPA also solicits information on the circumstances surrounding other incidents that EPA may not be aware of, especially information on the causes of the fires and the information and distribution of contaminants.

*C. Other Estimates of Fire Frequency*

Informal discussions between EPA representatives and representatives of the General Services Administration (GSA), regional fire departments, and the National Fire Administration have yielded some preliminary estimates of the frequency of fire-related incidents involving PCB-Transformers. EPA has obtained the following informal estimates: 3–4 fire-related incidents per 1,000 PCB-Transformers per year and 2–3 fire-related incidents involving PCB-Transformers per fire department per year.

If one assumes that there are 140,000 PCB-Transformers in service (as estimated by EPA in the August 25, 1982 PCB Electrical Use Rule), then, 3–4 fire-related incidents per year per 1,000 transformers would yield an estimate of between 420 and 560 fire-related incidents per year. If one assumes that all non-substation PCB-Transformers (114,469) are located in or around buildings, then, 3–4 fire-related incidents per year per 1,000 non-substation transformers would yield an estimate of between 342 and 456 PCB-Transformer fire-related incidents per year in buildings.

If one assumes that there is an average of 10 major fire department jurisdictions per State, and a total of at least 510 jurisdictions in the United States, then, a 2 or 3 fire-related transformer incidents per fire department yields an estimate of between 1,020 and 1,530 fire-related PCB-Transformer incidents per year.

In addition, from data collected in Finland on PCB-Transformer fires, the Director General of the Finnish Institute of Occupational Health (FIOH) estimated that there may be as many as 1,120 such incidents in the United States each year. This is based on the assumption that the frequency of fire-related events in the United States would be the same as that in Finland. EPA has contacted the Director General of FIOH to obtain additional data on the basis of his estimates.

Information compiled from the National Fire Incident Reporting System (NFIRS), a computerized data base managed by the National Fire Administration, indicates that there were 1,405 transformer fires in calendar year 1982. These data are not, however, specific to PCB-Transformers. EPA is in the process of obtaining access to this data base for purposes of determining the percentage of these fires that involved PCB-Transformers.

*D. Range of Estimates of the Frequency of PCB-Transformer Fires*

EPA has developed a range of preliminary estimates on the frequency of fire-related incidents involving PCB-Transformers. The lowest estimate is eight per year based on reports to EPA. The highest preliminary estimate, 1,530 fire-related incidents per year, is arrived at by assuming that fire departments throughout the United States respond to an average of 3 PCB-Transformer fire-related incidents each, per year.

Other preliminary estimates include 560 incidents per year (assumes 4 fire-related incidents per year per 1,000 PCB-Transformers), 1,120 incidents per year (assumes probability of a fire in the United States is equal to the probability of a fire in Finland), and 1,405 incidents per year (assumes all transformer fires reported to the NFIRS are PCB-Transformer fires).

EPA solicits data on the validity of the estimates provided above, as well as data to support other estimates of the frequency of fire-related incidents involving electrical transformers that contain PCBs.

## IV. Benefits of PCB Transformers and the Availability of Substitutes

*A. Benefits of PCBs*

PCBs were orginally used as dielectric fluid in electrical transformers primarily because of their fire-resistant properties. Traditionally, PCB-Transformers were placed in locations where concerns for fire safety were paramount. Even today, PCB-Transformers that are in storage for re-use are placed in or around buildings where fire safety is a concern. Other dielectric fluids, such as mineral oil, have superior electrical properties to PCBs, but their fire resistant properties are not as good as PCBs.

Thus, any consideration of phasing out PCB-Transformers must be accompanied by an analysis of the fire-resistant properties and potential toxicity of combustion products of substitute fluids. In addition, EPA must evaluate the adequacy of the electrical properties of these substitutes.

*B. Substitute Transformers*

In its August 1982 PCB Electrical Use Rule, EPA concluded that adequate substitutes exist for PCBs in indoor transformer locations. The following units summarize available information on the fire safety and electrical efficacy of substitute transformers, and discusses available information on the toxicity of substitute dielectric fluids in combustion situations.

There are six general types of substitutes for PCBs in transformers: Silicones, high-temperature hydrocarbons (HTH), chlorinated hydrocarbons, non-PCB askarels, fluorocarbons, and mineral oil. The following summarizes data available to EPA on the fire safety, toxicity in the event of a fire, and electrical efficacy of each type of substitute fluid.

There are several physical/chemical properties of substitute dielectric fluids that are used as a guide in determining fire safety. These properties are the

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autoignition temperature, the flash point, and the fire point. The minimum temperature at which a fuel bursts into flames when the stimulus is thermal is referred to as the autoignition temperature. The temperature at which first flames appear from a free radical source such as an arc, spark, or flame is referred to as the flash point. The fire point is a slightly higher temperature at which flames are sustained. Currently, the National Electrical Code requires a minimum fire point of 300°C for unvaulted electrical transformers.

The property of having a fire point higher than 300°C allows classification of fluids as "less flammable transformer fluids" by Factory Mutual Research Corporation (FMRC). During the past few years, FMRC, with the assistance of industry and government, has developed a philosophy for hazard reduction, performed experimental and theoretical research, and has issued a test sequence for recognition of less flammable transformer fluids.

The first requirement of the FMRC is that the fluid have a fire point of at least 300°C. This temperature is sufficiently high to afford resistance to small ignition sources, such as matches, but is still low enough to be met by several classes of commercial fluids, including silicone oil.

The next requirement is that the transformer be located within a dam that is at least four times the area of the transformer tank and is deep enough to contain all the fluid in the event of a spill. Should the fluid become ignited, and it is assumed that it will be, and become fully involved in flames, this insures that the flames will not spread along the floor.

The final requirement is a maximum allowable rate of convective heat release. In a nonflammable building with nonflammable contents, the risk of extensive fire loss is mainly to the structure itself. If the ceiling over the fire is overheated, collapse of the roof could occur. Heat release rates have been measured by FMRC for several fluids.

1. *Silicones.* Silicones refer to a family of relatively inert liquid organosiloxane polymers used as electrical insulation. Although silicone-filled transformers have been used since 1972, in the last five years, their use has increased significantly. They are superior to mineral oil and non-PCB askarels in thermal stability and, unlike mineral oil, will not degrade to form sludge. They also have fire points above 300°C.

Combustion of silicones, whether by arc-induced explosion or spray mist ignition, produces fluocculant silicone dioxide particles and globules of silica-gels. Breakdown products during arcing in the absence of oxygen are silicone dioxide, hydrogen, and hydrocarbons. Water, carbon dioxide, and carbon monoxide are also produced in the presence of oxygen. Silicone fluids are self-extinguishing when burned in a pool, since a crust is formed which smothers the flames.

Silicone transformer fluids also have some disadvantages. They absorb moisture from the air very rapidly and extreme care must be taken to transfer the fluid without contact with the atmosphere in order to maintain proper electrical properties. Product literature from one silicone fluid manufacturer roughly estimates that at 100°C, silicone fluids will circulate 5 or 6 times more slowly than askarel or mineral oil. This slower rate of circulation may have implications on the ability of the fluid to dissipate heat.

2. *High-temperature hydrocarbons (HTH).* EPA uses the term HTH to refer to mineral oils with a fire point higher than 300° C. This category of fluids includes high temperature esters that are primarily used in railroad transformers. The primary advantages of HTHs are high fire point, low toxicity, biodegradability, and the long usage history compared with other transformer oils. The higher fire point of HTH fluids mitigates somewhat the fire hazard normally associated with the use of mineral oil in indoor locations.

HTHs are refined from paraffinic-type base oil. Breakdown products from complete combustion during arcing in the absence of oxygen are hydrogen, carbon, and hydrocarbons. Products produced in the presence of oxygen include water, carbon dioxide, and hydrocarbons. Data are not available on the products of incomplete combustion of HTHs.

Ester HTHs are used primarily in railroad transformers or where transformers must start up under very cold conditions. Because their cost is higher than other HTHs and they offer no real advantages in indoor locations, it is likely that the paraffinic HTHs will be the materials of choice for these uses.

The viscosity of at least some HTHs decreases more rapidly than other transformer fluids under the action of increased temperatures associated with overloading. This property allows greater cooling during overload conditions.

The primary disadvantage associated with the use of HTHs is that they have a higher heat release rate than other substitutes. This mean that the HTHs will burn at over twice the temperature of silicone fluids, thus, potentially causing more damage in an indoor fire.

Another disadvantage of HTHs is the increased viscosity compared with that of mineral oils. This higher viscosity at normal operating loads causes slightly higher operating temperatures and could possibly shorten the life of the transformer.

3. *Chlorinated hydrocarbons.* Chlorinated hydrocarbons refer to a group of chlorinated aliphatic hydrocarbons. The primary chlorinated hydrocarbon being considered for use as a electrical insulating fluid is perchloroethylene. The primary advantage of perchloroethylene is its nonflammability.

Breakdown products from complete combustion during arcing include hydrogen, chloride, carbon, carbon monoxide, carbon dioxide, and water. Data are not available on the products of incomplete combustion of chlorinated aliphatic hydrocarbons.

4. *Non-PCB askarels.* Non-PCB Askarel is a generic term for a group of synthetic, fire-resistant, chlorinated aromatic hydrocarbons (chlorobenzenes) used as electrical insulating fluid. The primary advantages of the non-PCB askarels are their nonflammability and lower costs compared to HTHs and silicones. These fluids are treated the same as PCB-askarels in the National Electrical Code.

As mentioned in Unit II.B.2 of this Notice, however, experiments have shown the formation of PCDFs and PCDDs from the incomplete pyrolysis of mixtures of chlorobenzenes in air. Amounts of PCDFs ranged as high as tenths of a percent for mixtures of trichlorobenzenes.

5. *Fluorocarbons.* Fluorocarbons (specifically Freon 113) are being tested for use as a transformer fluid. EPA is soliciting information on the fire safety, electrical efficacy, and toxicity of freon fluids in fire situations.

6. *Mineral oil.* Mineral oil is a refined mineral insulating oil to which additives such as oxidation-inhibitor have been added. It is used in the vast majority of outdoor transformers.

If fire safety were not a consideration, mineral oil-filled transformers would probably be used in all applications. Mineral oils costs less than PCBs, have better heat transfer properties, are considerably lighter in weight, and form noncorrosive products under conditions of electrical arcing.

The major disadvantage of mineral oil is its flammability due to a low flash point. If arcing occurs, the complete combustion breakdown products are hydrogen, methane, other hydrocarbons, carbon monoxide, and water. Data are not available on the products of

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incomplete combustion of mineral oil. The National Fire Code requires, with some exceptions, that oil-insulated transformers installed indoors be placed in vaults. Because of the cost of installing tranformers in vaults, this is a disadvantage of mineral oil transformers.

As concluded in EPA's August 25, 1982 PCB Electrical Use Rule, EPA believes that adequate substitutes exist for PCBs in indoor transformer locations from the perspective of fire safety and electrical efficacy. EPA is soliciting information, however, on the toxicity of substitute transformer fluids in combustion situations. Specifically, EPA is soliciting data on the products of incomplete combustion of substitute dielectric fluids.

*C. Retrofilling PCB Transformers*

1. *Introduction.* Two general types of substitutes for PCBs in transformers stand out as the best retrofill candidates. These fluids are silicones and high temperature hydrocarbons (HTH). The principal questions to be considered are the cost of retrofill versus the value of the remaining life of the transformer and the qualification of the fluid as "less flammable" for insurance purposes. Other fluids, such as chlorinated hydrocarbons, fluorocarbon, and mineral oil, may be used in new transformers but are inappropriate for retrofilling because the design of the PCB-Transformers does not fit the properties of the fluids.

2. *Silicones.* There are six silicone fluids sold by six different companies for use as dielectric fluid. Four of the six fluids have been approved by Factory Mutual as "less flammable" fluids. Silicones have a higher viscosity than PCBs and are therefore not quite comperable as a coolant. For this reason, it is possible that transformers retrofilled with silicone would have to be derated. According to one silicone fluid manufacturer, if the transformer were fully loaded, a derating not exceeding five percent could be necessary.

It has been mentioned in the literature that a leaking problem could be created because silicone fluids are not compatible with silicone rubber gaskets and the coefficient of expension of silicone fluids is 30 percent greater than that of PCBs. In actual practice, however, the silicone gaskets are replaced during retrofilling. Further, even though the coefficient of expension is greater than that for PCBs, the greater solubility of the filler gas (nitrogen) in silicone eliminates that expected increase in pressure.

Experience with retrofilling PCB-Transformers since the issuance of the August 25, 1982 PCB Electrical Use Rule indicates that retrofilling with silicones to reclassify transformers as non-PCB is not practical at this time. In all, only one transformer retrofilled with silicone fluid has been able to reach and maintain levels under 50 ppm. Companies contacted during the past few months have all agreed that retrofilling to reach and maintain less than 50 ppm PCBs is not cost-effective. However, most thought that retrofilling to maintain levels under 500 ppm would be cost-effective in many cases.

3. *HTHs.* There are six HTH fluids sold be five companies that may be used as transformer dielectric fluids. There are also two products sold by two other companies that when mixed with other products may be used as HTH transformer fluids. Three of the six fluids are paraffinic-based oils and three are esters. As mentioned earlier, the three esters are more specialized for use in railroad transformers.

The other three fluids are more viscous than the silicones at lower temperatures, but thin more rapidly at higher temperatures. According to an HTH manufacturer, this property allows the transformers to be retrofilled with HTH without any derating. At lower normal load temperatures, however, the transformers do run hotter. These fluids are completely compatible with the materials that make up PCB-Transformers, and they are soluble in PCBs. Two of these fluids are approved by Factory Mutual as "less flammable transformer fluids," and the fire point of the third is over 300° C.

As with silicones, it does not seem practical to retrofill to maintain PCB concentrations under 50 ppm. However, it is possible and cost-effective in many cases to maintain concentrations under 500 ppm. The cost variables are about the same as for silicone fluids, except, HTH fluids require annual testing and possible filtering to remove moisture or particulates.

Because the paraffinic HTHs have high convective and radiant heat release rates, the owner's insurance company may recommend more stringent installation requirements.

EPA is soliciting comments on the information provided above pertaining to utilities' experience with retrofilling, and the ability practically to reduce PCB concentrations to below 50 ppm by retrofilling.

## V. Regulatory Options for Reducing Risks

*A. Preliminary Cost Effectiveness Analysis of Alternative Regulatory Options for PCB-Transformers*

1. *Clean-up costs.* There are two categories of clean-up costs that EPA considered in evaluating the cost-effectiveness of various options for PCB-Transformer phase-out. The first category is the clean-up of spills from transformers. In its August 25, 1982 PCB Electrical Use Rule, EPA assumed that 0.2 percent of PCB Transformers failed each year, and that 47.7 percent of these failures resulted in spills. EPA assumed that an average of $8,540 was spent per year per spill.

The second category of clean-up costs is the costs associated with the clean-up of catastrophic failures. For purposes of the following analysis, EPA assumes a catastrophic failure rate of 0.01 percent per year, and that clean-up costs are $30 million per incident. These costs were not factored into the Agency's economic analysis completed for the August 25, 1982 PCB Electrical Use Rule. EPA presents a range of estimates of the probability of catastrophic failures in Unit III.C. These probabilities range from 0.0089 percent per year (about 8 incidents per year) through 1.84 percent per year (about 1,530 incidents per year). (Additional tables that incorporate lower probabilities of catastrophic fires) are presented in the preliminary cost-effectiveness analysis completed for this ANPR (Ref. 11).)

EPA's estimate of clean-up costs associated with catastrophic events was derived from estimates provided from the Binghamton and San Francisco incidents. Further, in the analysis presented below, EPA assumes that little cost is normally associated with clean-up following non-PCB transformer fires in cases where little structural damage occurs to the building involved in the fire. EPA is soliciting data on the costs associated with clean-up following fires in transformers that do not contain PCBs.

2. *Comparison of clean-up costs versus phase-out costs.* The following table uses a population of 114,489 units (EPA's estimate of the number of non-substation PCB-Transformers) and an estimate of equipment life of 30 years, and compares phase-out costs to clean-up costs avoided if phase-out was implemented over a 5-year period, over a 10-year period, and over a 15-year period. EPA did not consider immediate phase-out because several persons indicated that manufacturing capacity was insufficient to allow for this option.

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For a full description of the assumptions used in the following analysis, and for a more detailed analysis of phase-out costs versus clean-up costs avoided, see "Preliminary Study and Cost-Effectiveness Analyses of Alternative Regulations for Indoor PCB Transformers, February 1984" (Ref. 11).

TABLE I—PRELIMINARY COST-EFFECTIVENESS OF ALTERNATIVE PCB REGULATIONS FOR PHASE-OUT OF UTILITY-OWNED ASKAREL TRANSFORMERS

| Regulation option | Cost [1] | Clean-up costs avoided [1] | PCB released/ prevented (pounds) |
|---|---|---|---|
| 15-year phase-out | $200.6 | $165.1 | 580,000 |
| 10-year phase-out | 341.1 | 470.6 | 580,000 |
| 5-year phase out | 8 040.2 | 1,080.9 | 755,000 |

[1] In millions of dollars.

3. *Retrofilling.* EPA has completed a preliminary analysis of the costs of retrofilling PCB-Transformers to reduce PCB concentrations to below 500 ppm. EPA estimates that retrofill costs will range from $20,736 to $32,034 per transformer, depending upon the size of the transformer. These estimates do include the costs of disposal of PCB fluid, but do not include any consideration of a loss of efficiency or derating as a result of the retrofill.

An estimate of the total costs of requiring the retrofilling of all PCB-Transformers (114,469 in service non-substation transformers) to below 500 ppm is about $1.5 billion. This can be compared to an estimate of clean-up costs avoided of about $1.7 billion. This estimate of clean-up costs avoided assumes that retrofilled transformers that contain less than 500 ppm PCBs that are involved in fire-related incidents would not result in the formation of PCDFs or PCDDs in sufficient quantities to trigger major clean-up efforts. EPA does not know whether this is a valid assumption. EPA is soliciting data on the potential for the former of PCDFs and PCDDs in PCB-Contaminated transformers.

EPA also completed a preliminary analysis of the costs of retrofilling of PCB-Transformers to reduce the concentration of PCBs to 6 percent. An estimate of the total costs of requiring retrofilling of all non-substation PCB-Transformers to 6 percent PCBs is about $1.3 billion. EPA is also soliciting data on the formation of PCDFs and PCDDs in this category of transformers. For additional information on the costs of requiring retrofilling, see "Preliminary Study and Cost-Effectiveness Analyses of Alternative Regulations for Indoor PCB Transformers, February 1984" (Ref. 11).

4. *Fire hazard inspections.* Following the transformer fire in San Francisco, the owner of the transformer involved in the fire (Pacific Gas and Electric Company (PG&E)) instituted a fire hazard related inspection program for PCB-Transformers. This program consisted of inspecting all network PCB-Transformers on a regular and frequent basis, using new techniques such as infrared sensors to detect potential defects ("hot spots") in the transformers and electrical equipment in the area of the transformers. In addition, for increased fire protection, PG&E installed secondary disconnect switches at PCB-Transformer locations.

EPA believes that completing transformer fire hazard inspections of PCB-Transformer locations may be the initial step in a program to reduce the likelihood of future fires involving this equipment and to mitigate risks associated with these fires should they occur. Other factors considered in a transformer fire hazard inspection might include a consideration of: The age of the transformer and the maintenance history, the location of the transformer, the location of ventilation equipment or ductwork in the vicinity of the transformer, and the presence of combustibles in a transformer vault or near a transformer location.

EPA is soliciting data on the effectiveness and costs of using infrared sensors to identify potentially faulty equipment. EPA is also soliciting data on the effectiveness and costs of other similar technologies, and information on the effectiveness and costs of installing and using secondary disconnect switches exterior to transformer locations. EPA is soliciting comments on its list of factors to be considered in fire hazard inspections, and comments on the ability to reduce the potential for fires by completing fire hazard inspections and instituting appropriate corrective measures. EPA is soliciting information on other factors that should be included in a PCB-Transformer fire hazard inspection, and information on the costs of conducting such inspections.

5. *Fire/smoke control technologies.* PG&E, in addition to completing fire hazard inspections, has committed to sealing off all openings through its network vaults. Presumably, this is being done to reduce the spread of smoke to areas adjacent to the transformer location in the event of a fire. EPA has obtained a preliminary range of estimates of the costs associated with sealing off transformer locations to reduce the spread of contaminated smoke. These estimates range from $2,000 to $5,000 per transformer location (Ref. 11).

In addition to closing off transformer locations through the use of sealants, EPA believes that the use of smoke detectors and other sensors in transformer locations to create an early warning system may be beneficial in mitigating the risks from fires involving transformers. Further, the use of a heat-sensitive or smoke-sensitive baffling system in ventilation ducts exiting the transformer location could reduce the spread of contaminants via this route. For additional information on the economics of implementing these types of risk reduction measures, see "Preliminary Study and Cost-Effectiveness Analyses of Alternative Regulations for Indoor PCB Transformers, February 1984" (Ref. 11).

EPA is soliciting information on available smoke and fire control technologies, their application to PCB-Transformer fire situations, their ability to reduce the risks associated with these fires, and the costs associated with installing these systems.

6. *Reporting of PCB-Transformer fires to EPA.* EPA is soliciting comments on the benefits of instituting a PCB-Transformer fire reporting system within the EPA. EPA believes that specifically requiring the reporting of these incidents would increase the general level of knowledge about how these incidents occur, the circumstances surrounding these incidents, and the nature and level of risks posed by these incidents. EPA is soliciting comments on the costs associated with requiring such reporting, and the benefits to public health from such a system. EPA solicits comments on the mechanics of such a system, including comments on considerations such as: (1) Who would be responsible for reporting the fire, (2) when the report must be filed, and (3) what types of information must be reported.

7. *Registration of PCB-Transformers with fire departments.* PG&E, in a telephone conversation with EPA, indicated that it routinely informs fire departments of the location of PCB-Transformers in the utility system. Representatives of the International Firefighters Association and representatives of fire departments have informally indicated to EPA their desire to see this practice instituted nationwide. EPA believes that the risks posed to firemen and bystanders during PCB-Transformer fires could be significantly reduced if the initial response team is aware that the fire involves a PCB-Transformer, and that there are certain risks associated with extinguishing such a fire.

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EPA is soliciting comments on the effectiveness of supplying this information to fire departments from the perspective of reducing the risks posed from these incidents to firemen and bystanders. EPA is also soliciting data on the costs of providing these data to fire department jurisdictions.

*B. Utilities That Have Made Decision Voluntarily to Phase Out PCB-Transformers*

1. *PG&E.* PG&E has decided to replace its 539 PCB-Transformers in the San Francisco area on a priority basis by December of 1987. According to PG&E, 40 PCB-Transformers in vault locations are to be replaced by June 16, 1984, and 45 PCB-Transformers in 12 high-rise buildings are to be replaced by June 16, 1984. The remaining PCB-Transformers are to be removed by the December 1987 date.

In the interim, PG&E is completing PCB-Transformer fire hazard inspections, sealing openings in vaults, and placing secondary disconnect switches at PCB-Transformer locations.

2. *Florida Power and Light.* Florida Power and Light Company (FPLC) has also committed to replacing its 458 PCB-Transformers. In September 1983, FPLC announced its plans to spend more than $15 million in south Florida over a five-year period to replace this equipment. Details on the priority system for the removal of these transformers was not available to EPA, but, EPA is interested in obtaining this type of information.

3. *Boston Edison.* According to a letter dated August 8, 1983 from Boston Edison Company (BEC) to a property management firm, BEC is in the process of developing programs for the orderly elimination of PCB equipment from their system. BEC indicates that they have already begun the examination of transformer vaults in buildings for purposes of determining what work will be required and when it may be scheduled. EPA has no further details on BEC's decision or on its priority system for the removal of this equipment. EPA is soliciting additional information.

EPA is soliciting information from other utilities or building owners that have made the decision to remove PCB-Transformers from their present locations, and data on the basis for making the decisions to phase out this equipment.

## VI. Summary of Data Needs for Proposed Rule

*A. Risks Posed by Fires*

1 *Number, location, and ownership of PCB-Transformers.* EPA is soliciting information on the types of buildings in which PCB-Transformers are used, the number of PCB-Transformers used in each building, the age of the buildings, the age of the transformers, the location of the PCB-Transformers serving the buildings, and the ownership of the transformers. EPA is also soliciting information on the location of PCB-Transformers other than those present in or directly servicing buildings.

2. *Populations exposed, types of chemicals, and levels of exposure.* EPA is soliciting information on populations potentially exposed to PCBs and PCB-oxidation products in the event of a fire, and the levels of chemicals to which the populations are potentially exposed.

3. *Routes of exposure to PCBs and oxidation products.* EPA is soliciting information on the potential routes of exposure to PCBs and their oxidation products to the event of a fire involving this equipment. EPA is soliciting information on the role of ventilation equipment and ductwork in the dispersion of PCBs and oxidation products from PCB-Transformers involved in fires.

4. *Representativeness of Binghamton and San Francisco data.* EPA is soliciting comments on its analysis of the Binghamton and San Francisco fires and on the representativeness of these fires from the perspective of evaluating the nature of the risks posed when a PCB-Transformer is involved in a fire-related incident.

5. *Information on the risks posed by the fire in Chicago.* EPA is soliciting additional data on the causes of and circumstances surrounding the September 1983 Chicago fire, as well as information on the risks posed from this incident.

6. *Information on other fire-related incidents involving PCB-Transformers.* EPA is soliciting data on other PCB-Transformer fire-related incidents in addition to data on Binghamton, San Francisco, and Chicago. EPA is soliciting data on the time, date, and location of the incident; the cause of the incident; the extent and avenue of smoke travel; the location of ventilation equipment relative to the location of the fire; the type of equipment involved in the incident; the age of the equipment; the type of building in which the incident occurred; the number of people present in the building at the time of the incident; the time elapsed between the beginning of the fire and the response of the fire department; the time required to de-energize the transformer; the effectiveness of the circuit breaker as a protection device in the incident; the potential for the formation of oxidation products such as PCDF and PCDD; levels of PCBs, PCDFs, PCDDs, and other oxidation and pyrolysis products measured in the building following the fire; the nature of any clean-up undertaken following the incident; and, the costs of clean-up following the incident.

7 *Factors that may increase/decrease the risks posed by PCB-Transformers in the event of a fire-related incident.* EPA is soliciting information on factors, such as the failure of protection devices, the location of ventilation equipment, the type of building in which a fire occurs, etc. that may increase the risks posed to humans and the environment from fires involving PCB-Transformers. In addition, EPA is soliciting information on factors that may decrease these risks.

8 *Exposures and risks resulting from contaminated water at fires.* EPA is soliciting comments on exposures and risks that may result from water contaminated at fires. Contaminated water may result from the application of water during firefighting, the rupturing of pipes under high temperatures, and possibly other sources including water from clean-up operations following the fire. Contaminated water may enter sewer systems (both sanitary and storm sewer systems) and may run off directly to surface water. Contamination of sewers, treatment works, sludges and surface water may result. EPA solicits information and data on the distribution of PCBs and other toxic chemicals through such routes, including the mode of distribution and environmental fate; actual or anticipated concentration levels in water, sludge, treatment systems and biota; adverse effects on and continuing risk to humans through drinking water or ingestion of contaminated food; risk to other organisms; threat to the operation of sewage treatment systems; and the costs of clean-up.

*B. Frequency of Fire-Related Incidents*

EPA is soliciting comments from building owners, fire departments, utilities, and other parties on the accuracy of EPA's nationwide estimates of the frequency of fire-related incidents involving PCB-Transformers. EPA is also interested in data on the frequency of these fires versus the age of the transformers involved.

*C Formation of Reaction Products*

1. *The reaction products found following PCB-Transformer fires.* EPA is soliciting information on the types and levels of oxidation/pyrolysis/incomplete combustion products that are found following fire-related incidents involving PCB-Transformers.

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2. *The reactions and mechanisms of reactions involved in the formation of reaction products.* EPA is soliciting information on the reactions and mechanisms of reaction involved in the formation of oxidation/pyrolysis/incomplete combustion products from PCB-Transformer fires.

3. *The potential for the formation of reaction products following fires involving PCB-Contaminated Transformers.* EPA is soliciting data on the potential for the formation of toxic reaction products from fires involving PCB-Contaminated Transformers.

*D. Costs and Nature of Costs Associated With Clean-Up*

EPA is soliciting information on the costs incurred by owners of PCB-Transformers involved in fire-related incidents. These costs include the costs of analysis, the costs of clean-up and removal of contaminated materials, the costs of lawsuits filed by damaged parties, and the costs of replacing the damaged vault and/or transformer(s) following the incident. EPA is also soliciting data on the size of the area cleaned, the levels remaining after clean-up, and other explanatory information on how clean-up money was spent, and why clean-up required the amount of money used.

*E. Costs and Benefits of Regulatory Options*

1. *Benefits of PCBs.* EPA is soliciting specific information concerning whether transformer fire incidents have been reduced over the past 40 years due to PCB usage, whether this usage has made a significant impact on reducing the dollar costs from building fires, and whether such usage has resulted in any appreciable saving of human life.

2. *Substitute transformers.* EPA is soliciting information on the toxicity of substitute dielectric fluids in the event of a fire.

3. *Retrofilling.* EPA is soliciting information on the fire safety, electrical efficacy and toxicity (in the event of a fire-related incident) of PCB-Transformers that have been retrofilled with non-PCB fluid. EPA is also soliciting comments on the FEDCo Environmental Inc. study of substitute transformers and dielectric fluids.

4. *Identifying high risk transformers.* EPA is soliciting information on what constitutes a high risk PCB-Transformer from the perspective of hazards posed in the event of a fire-related incident, and methods for identifying such a transformer. EPA is soliciting information on the costs associated with inspecting all PCB-Transformer locations to determine which PCB-Transformers would pose higher risks in the event of PCB-Transformers that may be considered to be high risk transformers.

5. *PCB-Transformer phase-out costs.* EPA is soliciting information on the costs to transformer owners of requiring the phase-out of all PCB-Transformers over 5-, 10-, or 15-year periods. EPA is also soliciting comments on the Putnam Hayes and Bartlett Preliminary Study and Cost-Effectiveness Analyses of Alternative Regulations for Indoor PCB-Transformers (Ref. 11).

6. *Phase-out costs of high risk PCB-Transformers.* EPA is soliciting information on the costs to transformer owners of requiring the phase-out of PCB-Transformers that fall within the high risk categorization.

7. *Fire hazard inspection programs.* EPA is soliciting information on what factors should be included in a PCB-Transformer fire hazard inspection, and on the effectiveness of inspections and subsequent corrective measures in reducing the probability of fires and mitigating the risks posed when fires do occur. EPA is also soliciting information on the costs associated with completing these inspections and the costs associated with implementing corrective measures following inspection.

8. *Availability and effectiveness of early detection devices and smoke control technologies.* EPA is soliciting information on the effectiveness of early detection devices in reducing the risks associated with PCB-Transformer fire-related incidents. EPA is also soliciting information on the availability of smoke control technologies to reduce the spread of the contaminated smoke from fires involving PCB Transformers. EPA is soliciting data on the effectiveness of these technologies in the event of an electrical power failure, which often accompanies PCB-Transformer fire-related incidents.

9. *Effectiveness and costs of PCB-Transformer fire reporting system.* EPA is soliciting information on the costs and benefits of instituting an EPA PCB-Transformer fire reporting system.

10. *Registration of PCB-Transformers with fire department jurisdictions or with EPA.* EPA is soliciting data on the costs and benefits of registering PCB-Transformer fires with local fire departments or with regional offices of the EPA.

11. *Utilities that are phasing out PCB-Transformers.* EPA is soliciting information from all utilities that have made the decision to phase out PCB-Transformers. EPA is interested in obtaining information on the rationale for instituting these phase-out programs.

## VII. References


(1) USEPA, OPTS, EED, Versar, Inc., "Exposure Assessment: Fires Involving PCB-Transformers" (January 1984).

(2) USEPA, OPTS, HERD, "Response to Comments on Health Effects of PCBs submitted by the Chemical Manufacturers Association and the Edison Electric Institute" (August 18, 1982).

(3) USEPA, Carcinogenic Assessment Group, "The Carcinogenic Assessment Group's Risk Assessment on (2,4,5-Trichlorophenoxy) Acetic Acid (2 4,5 -T) (2,4,5,-Trichlorophenoxy) Propionic Acid (Silvex) 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)" (September 12, 1980).

(4) Casarett and Doull, (1975) "Toxicology the Basic Science of Poisons," MacMillan Publishing Co., Inc., pp. 23-28.

(5) Oishi, S. Morita, M., Fukuda, H., (1978) "Comparative Toxicity of Polychlorinated Biphenyls and Dibenzofurans in Rats," Toxicology and Applied Pharmacology, 43, 13-22.

(6) USEPA, OPTS, HERD, "The Toxicity of Soot From PCB Transformer Fires" (December 20, 1983).

(7) OGS, (1983) "The Binghamton State Office Building Clean-up: A Progress Report Update," Albany, NY: New York State Office of General Services (January 1983).

(8) Versar, "Investigation of the Contamination Remaining in the Binghamton State Office Building Following Completion of Preliminary Clean-up" (October 20, 1982).

(9) The Equitable Life Assurance Society of the United States, Letter to David Dull, EPA, "Equitable Life Assurance Survey" (October 4, 1983).

(10) USEPA, OPTS, EED, "Summary of Regional Data on PCB-Transformer Fires" (October 18, 1983).

(11) USEPA, OPTS, ETD, PHB, "Preliminary Study and Cost-Effectiveness Analyses of Alternative Regulations for Indoor PCB Transformers" (February 1984).

(12) USEPA, OPTS, ETD, FEDCo Environmental, Inc., "Substitutes for PCBs for Use in Indoor Electrical Transformers" (January 1984).

(13) Mitre Corporation, "Environmental Assessment of PCBs in the Atmosphere," Tables 8-11 and 8-12 (April 1978).

(14) Buser, Hans Rudolf, "Formation of Polychlorinated Dibenzofurans (PCDFs) and Dibenzo-p-Dioxins (PCDDs) from the Pyrolysis of Chlorobenzenes" (1978).

(15) Buser, Hans Rudolf, "Formation of Polychlorinated Dibenzofurans (PCDFs) from the Pyrolysis of PCBs" (1978).

(16) Buser, Hans Rudolf, "Formation of Polychlorinated Dibenzofurans (PCDFs) from the Pyrolysis of Individual PCB Isomers" (1979).


## VIII. Rulemaking Record

EPA is issuing the following list of documents which constitutes the record for this rulemaking, and requests comments on any other documents that should be included. Documents will continue to be added to the record as

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appropriate, including information submitted in response to this rule.

*A. Previous Rulemaking Records*

(1) Official rulemaking record from "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibition Rule" published in the Federal Register of May 31, 1979 (44 FR 31514).

(2) Official rulemaking record from "Polychlorinated Biphenyls (PCBs); Disposal and Marking Final Regulation" published in the Federal Register of February 17, 1978 (43 FR 7150).

(3) Official rulemaking record from Polychlorinated Biphenyls (PCBs); Manufacture, Processing, Distribution, and Use in Closed and Controlled Waste Manufacturing Processes" published in the Federal Register of October 21, 1982 (47 FR 46980).

(4) Official rulemaking record from Polychlorinated Biphenyls (PCBs); Manufacturing, Processing, Distribution in Commerce and Use Prohibitions; Use in Electrical Equipment" published in the Federal Register of August 25, 1982 (47 FR 37342).

*B. Support Documents*

(1) USEPA, OPTS, EED, Telephone Communications between Denise Keehner, EPA, and Peter Cillson, GSA, "Frequency and Nature of PCB Transformer Fires" (October 5, 1983).

(2) USEPA, OPTS, EED, Telephone Communications between Denise Keehner, EPA, and David Endicott, National Fire Administration, "Data in the National Fire Incident Reporting System for 1982" (November 10, 1983).

(3) USEPA, OPTS, EED, Telephone Communications between Denise Keehner, EPA, and Gary Girod, Ventura County Fire Protection District, "Frequency of PCB-Transformer Fires" (August 22, 1983).

(4) USEPA, OPTS, EED, Telephone Communications between Denise Keehner, EPA, and Meg Pietrasz, Pacific Gas and Electric, "Information on PCB-Transformer Fire in San Francisco" (December 1, 1983).

(5) United States Department of Energy, Center for Fire Research, "Development of Flammability Criteria for Transformer Dielectric Fluids" (March 1980).

(6) Pacific Gas and Electric Company, Letter to Mr. Harry Seraydarian, USEPA Region IX, "PCB Transformer Fire in San Francisco" (June 20, 1982).

(7) Pacific Gas and Electric Company, Letter to Mayor Dianne Feinstein, "Plan to Remove PCB-Transformers" (June 16, 1983).

(8) USEPA, OPTS, EED, Record of Meeting between EPA and Dow Corning, "Retrofilling and PCB-Transformer Fires" (September 20, 1983).

(9) Chemical Regulation Reporter, Article on PCB-Transformer Fires, "U.S. Can Expect 1,130 Transformer Fires Each Year, Finnish Scientist Tells NIEHS" (September 23, 1983).

(10) Jorma Rantanen, Director General, Institute of Occupational Health, Letter to Don Clay, EPA, "Incidence of PCB-Transformer Fires" (November 23, 1983).

(11) USEPA, OPTS, EED, Record of Meeting between Bob Westin of Versar and Denise Keehner, EPA, "PCB-Transformer Fires Issue" (week of September 26, 1983).

(12) USEPA, OPTS, EED, Telephone Communication between Leo Kokoszka, EPA and Steve Farrow, USEPA Region VIII, "PCB-Transformer Fires and Related Incidents" (October 18, 1983).

(13) Buser, H. R. (1979). "Formation of Polychlorinated Dibenzofurans (PCDFs) and Dibenzo-p-dioxins (PCDDs) from the Pyrolysis of Cholorobenzenes," Chemosphere No. 8, 415-424.

(14) The New York Times, "Florida Utility Will Replace Transformers Made With Toxic PCB's" (Thursday, September 8, 1982).

(15) USEPA, Office of Water Regulations and Standards, Criteria and Standards Division, "Ambient Water Quality Criteria for 2,3,7,8-Tetrachlordibenzo-p-dioxin" (February 1984).

List of Subjects in 40 CFR Part 761

Hazardous materials, Labeling, Polychlorinated biphenyls, Reporting and recordkeeping requirements, Environmental protection.

Dated: March 14, 1984.

William D. Ruckelshaus,

*Administrator.*

[FR Doc. 84-7555 Filed 3-22-84; 8:45 am]

BILLING CODE 6560-50-M

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