Part I — Inerteen® Insulating Fluid

CHARACTERISTICS

Inerteen is a highly pure, synthetic non-inflammable and non-explosive insulating and cooling liquid. Chemically stable and nearly water white in color, Inerteen is not affected by reaction with other materials regularly used in the manufacture of Inerteen apparatus. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in Inerteen apparatus. Inerteen will not sludge under any operating condition. Water is the main enemy of Inerteen and keeping it dry will insure long service life.

The dielectric strength of Inerteen will compare favorably with that of insulating oil when tested under the same conditions. Quality samples of Inerteen tested under laboratory conditions may show a dielectric strength in excess of 40 kv. Care must be exercised in handling and testing Inerteen. Inerteen must be kept in clean, sealed containers to prevent loss by evaporation or contamination by moisture or dirt.

Inerteen exerts a strong solvent action on most varnishes, gums, and paints. Such materials are not used in the construction of Inerteen apparatus. No materials should be used in Inerteen apparatus except those approved by the Westinghouse Electric Corporation.

Inerteen has an irritating effect upon the skin. If it is necessary to handle it, see the caution note on the title page. It should be remembered that mineral oil is completely miscible with Inerteen; in fact, it is impossible to separate mineral oil and Inerteen.

Specific Characteristics of Inerteen

As outlined in "Method of Testing Askarels A.S.T.M. D901," the specific characteristics of Inerteen are:

1. Burn point: None

2. Chemical stability: No generation of free chlorides under normal operating conditions

3. Color: (Maximum) 100 A.P.H.

4. Condition: Clear

5. Dielectric constant:

At 1000 cycles 77°F (25°C), 5.7 to 5.9
At 1000 cycles 212°F (100°C), 4.8 to 5.0

6. Dielectric strength: (Minimum) 77°F (.

At point of shipment, 35 kv
At point of receipt, 30 kv

7. Electrical Resistivity: (Minimum)

500×10^9 ohms/cm^3 (212°F (100°C) at 500 volts d-c)

8. Power factor:

At 60 hertz, 77°F (25°C) 2%
At 60 hertz, 212°F (100°C) 25%

9. Fixed chlorine content: (Minimum) 42 percent

10. Free chlorides: Less than 0.10 ppm

11. Neutralization number: Less than 0.01 of NaOH/gram

12. Pour Point: (Maximum) plus 2°F (minus 19°C)

13. Refractive index:

At 77°F (25°C), 1.624 to 1.626

14. Specific gravity:

At 60°F/60°F (15.5°C/15.5°C), 1.381 to 1.392

15. Density: 11.5 pounds per gallon

16. Viscosity:

At 100°F (37.8°C), 82-92 seconds

17. Moisture: (Maximum) 35 ppm

HANDLING

CAUTION

Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor, particularly





PLASTEK

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SPECIFICATION

FOR

NEW, UNUSED TRANSFORMER-TYPE ASKARELS

FEBRUARY, 1975

PREPARED BY THE INSULATING FLUIDS SUBCOMMITTEE OF THE

IEEE TRANSFORMERS COMMITTEE

NPC00036711

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1. SCOPE AND INTRODUCTION

1.1 - This specification covers bulk shipment in tank cars and drums of new, synthetic, nonflammable electrical insulating liquids of the chlorinated aromatic type known as askarels which are used as insulating and cooling media in liquid-filled transformers. While this specification is intended to cover the composition and characteristics of askarels for purchase only and does not apply to liquids in apparatus, a number of discontinued types are included for purposes of identification and historical significance.

2. DEFINITION

2.1 - Askarel is a generic term describing a widely used broad class of nonflammable synthetic halogenated hydrocarbon insulating liquids. Askarels of various compositional types are used. Under arcing conditions the gases produced, while consisting of predominantly noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

3. CAUTION

3.1 - Transformer askarels contain polychlorinated biphenyls (PCB's) considered by many to be an environmental contaminant. Proper handling and disposal procedures should be exercised to prevent their entry into the environment. Such procedures are covered in the IEEE Guide for Acceptance and Maintenance of Transformer Askarel in Equipment, Std. 7[illegible]-1974, and in the American National Standard, Guidelines for Handling and Disposal of Capacitor - and Transformer - Grade Askarels Containing Polychlorinated Biphenyls, C107.1 (1974).

4. SAMPLING AND METHODS OF TEST

4.1 - The material shall be sampled in accordance with ASTM Method D923, Sampling Electrical Insulating Liquids, and tests shall be conducted in accordance with the methods of test listed in Table II.

5. COMPOSITION

5.1 - Askarels covered by this specification are of several types which are mixtures having the approximate compositions in weight per cent as shown in Table I. Some types of askarels are included for identification and historical significance. The components and respective percentages are descriptive of the materials in common use and are not intended as part of this specification which is based on the physical, chemical and electrical properties given in Table II.



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TABLE I

ASKAREL COMPONENTS IN WEIGHT PER CENT

COMPONENTS	Type A	Type B	Type C	Type D	Type E	Type F	Type
Commercially available as of 1974	No	No	No	Yes	Yes	No	Y
Hexachlorobiphenyl (1)	60	45					
Pentachlorobiphenyl (2)				70		45	6
Trichlorobiphenyl (3)			80		100		
Trichlorobenzene (4)	40			30			4
Tri-tetrachlorobenzene (5)		55	20			55	
Phenoxypropene oxide (6)	0.18 to 0.22			0.18 to 0.22	0.18 to 0.22		
Diepoxide-type compound (7)		0.115 to 0.135	0.115 to 0.135			0.115 to 0.135	0.1 to 0.13

Note (1): Biphenyl chlorinated to a chlorine content of 60 weight per cent -- predominantly hexachlorobiphenyl but containing significant amounts higher and lower chlorinated biphenyls.

Note (2): Biphenyl chlorinated to a chlorine content of 54 weight per cent -- predominantly pentachlorobiphenyl but containing significant amounts higher and lower chlorinated biphenyls.

Note (3): Biphenyl chlorinated to a chlorine content of 42 weight per cent -- predominantly trichlorobiphenyl but containing significant amounts o higher and lower chlorinated biphenyls.

Note (4): Basically a mixture of isomers of trichlorobenzene but with smaller amounts of benzene chlorinated to other degrees.

Note (5): Approximately a mixture of the isomers of trichlorobenzene (73% by weight) and tetrachlorobenzene (27% by weight) but with smaller amounts of benzene chlorinated to other degrees.

Note (6): Glycidyl-phenyl ether.

Note (7): 3,4-Epoxycyclohexylmethyl-3,4-Epoxycyclohexanecarboxylate

6. DETAIL REQUIREMENTS

Askarels for use in transformers shall conform to the requirements prescribed in Table II.

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TABLE II

DETAIL REQUIREMENTS FOR ASKARELS FOR TRANSFO

PROPERTY	Type A	Type B	Type C		
Acidity, mgKOH/g, max.	0.014	0.014	0.014		
Color, APHA, max.	150	150	150		
Condition	Clear	Clear	Clear	C	
Chlorides, inorganic, ppm, max.	0.1	0.1	0.1	0.	
Dielectric Constant @ 100C and 1 kHz	3.7 to 4.0	3.8 to 4.3	4.4 to 4.9	4. 4.	
Dielectric breakdown voltage, kV, min.	35	35	35	3	
Fire point(1)	None to Boiling	None to Boiling	None to Boiling	None Boil	
Pour point, °C, max.	-32	-44	-30	-30	
Refractive Index @25°C	1.6130 to 1.6154	1.6068 to 1.6088	1.6146 to 1.6166	1.616 to 1.6193	
Resistivity at 100C, 500 Vd-c, ohm-cm, min. (2)	100×10^9	100×10^9	100×10^9	100×10^9	
Scavenger content, per cent					
Phenoxypropene oxide	0.18 to 0.22			0.18 to 0.22	
Diepoxide-type compound		0.115 to 0.135	0.115 to 0.135		D
Specific Gravity @15.56°C	1.560 to 1.568	1.560 to 1.571	1.412 to 1.425	1.518 to 1.528	D18
Viscosity, Saybolt Universal, s at 37.8C	52 to 56	41 to 45	50 to 55	56 to 61	D88
Viscosity, kinematic cSt at 37.8C	8.0 to 9.2	4.6 to 5.8	7.4 to 8.9	9.2 to 10.6	D445
Coefficient of thermal expansion(3), $Cm^3/Cm^3/°C$	0.0007	0.0007	0.0007	0.0007	D1903
Water content, ppm, max.	30	30	30	30	D1533

	Type E	Type F	Type G	ASTM Test Method (4)
Acidity, mgKOH/g, max.	.014	.014	.014	D974, D664
Color, APHA, max.	150	150	150	D2129
Condition	Clear	Clear	Clear	(Visual)
Chlorides, inorganic, ppm, max.	0.1	0.1	0.1	D1821
Dielectric constant at 100C and 1 kHz	4.7 to 4.9	4.5 to 4.9	4.3 to 4.6	D924
Dielectric breakdown voltage, kV, min.	35	35	35	D877
Fire Point(1)	None to Boiling	None to Boiling	None to Boiling	D92

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TABLE II - (Cont'd)

PROPERTY	Type E	Type F	Ty	
Pour Point, °C, max.	-14	-42	-3	
Refractive Index @ 25°C	1.6240 to 1.6260	1.6060 to 1.6070	1.6 to 1.61	
Resistivity at 100C, 500 V d-c, ohms-cm, min.(2)	100×10^9	100×10^9	100x1	
Scavenger content, per cent				
Phenoxypropene oxide	0.18 to 0.22			
Diepoxide type compound		0.115 to 0.135	0.115 to 0.135	
Specific Gravity @ 15.56°C	1.381 to 1.392	1.522 to 1.532	1.502 to 1.517	
Viscosity, Saybolt Universal, s at 37.8C	82 to 92	39 to 43	44 to 48	
Viscosity, kinematic, cST at 37.8C	16.2 to 18.6	4.0 to 5.3	5.5 to 6.8	
Coefficient of thermal expansion(3) $cm^3/cm^3/°C$	0.0007	0.0007	0.0007	D1
Water content, ppm, max.	30	30	30	D15

Note (1): When testing for fire point, a pseudo-flash may be observed; differs noticeably from the flash obtained on combustible mat and is not indicative of a fire hazard.

Note (2): If more convenient, a measurement of power factor may be made b ASTM Method D924, Test for Power Factor and Dielectric Constant of Electrical Insulating Liquids, in place of the resistivity measurement. Theoretical considerations indicate and experiment confirms that a strong statistical correlation exists between power factor and resistivity; however, other factors modify in practice the precise relationship predicted by theory. A power factor at 60 Hz and 100C that is not in excess of 15 per cent shall be considered satisfactory.

Note (3): These are approximate values included for information only.

Note (4): These designations refer to test methods under the jurisdiction of Committee D27 on Electrical Insulating Liquids and Gases of the American Society for Testing and Materials.

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Exhibit 1

not for retention
but for BG
reading

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A series of talks presented at the Westinghouse Distribution Apparatus Division to state and local officials on

April 13, 1976

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Wh PCBs in Electrical Equipment

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by
D. M. Sauter, General Manager
Distribution Apparatus Division
Westinghouse Electric Corporation
Bloomington, Indiana

For over 40 years, electrical manufacturers have used large quantities of polychlorinated biphenyl compounds (PCBs) for production of electrical capacitors and transformers. PCBs have excellent dielectric properties and fireproof characteristics. Therefore, the unique combination of good electrical and safety properties when used in electrical equipment are key reasons why PCBs have not been replaced over this 40-year time span.

For the moment let's explore the electrical system and the use of capacitors and transformers in the electrical system. The United States is criss-crossed by thousands of electrical transmission lines. These lines act as a vehicle and carry electrical power from the source of power, the electrical generator, to large urban areas, or to centralized areas within rural districts. The electric power is then distributed to homes, offices, factories and farms.

Although the transformer is extremely efficient in performing its function of raising voltages and permitting power to be transmitted over long distances, losses do occur in the transformer and along the transmission line, as the current flows through these circuits. However, all is not lost because the capacitor provides the way of improving efficiency of all of our electrical systems. A capacitor has the same effect as the generator only in a smaller sense. For example, a capacitor can be applied at the electrical load to supply a portion of the current required by motors and transformers. By placing capacitors at the electrical load end of the transmission and distribution line, the current is not required to flow through the transmission line. Less current means high efficiency of the electrical system. Improved efficiency means that less oil, less gas and less coal is required to get the electrical power to each home, or industrial plant. Capacitors have helped make U.S. Power Systems the world's most efficient.

Large capacitors are used in high-voltage electrical systems. Smaller capacitors are applied in television sets, fluorescent lights, air conditioners, and in many of the motors and circuits used in industrial plants and commercial buildings. These alternating-current capacitors are applied at voltages from 110 volts (a normal house voltage) to 500,000 volts (a high-transmission voltage).

Capacitors were first used in power systems in the 1930s. During World War II, the electric utilities began to buy capacitors in large amounts. The reason is that capacitors involved less critical material and provided the simplest way to increase the efficient use of available electrical energy.

Since then, there have been increased applications of capacitors worldwide. Moreover, the recent energy shortage has again focused attention on improving the efficient use of electricity. For instance, capacitors are applied on additional end-use devices, such as washing machines, microwave ovens, room air conditioners, television sets, etc. Capacitors and transformers have always been used on fluorescent lights.

Electricity creates corona. Corona are small impulses similar to lightning. If these impulses are allowed to build up, they will flashover and cause a significant short circuit. To control corona, a liquid is generally added to the other dry dielectrics. This liquid suppresses or restrains the electrons caused by the corona. It allows electrical equipment then to withstand hundreds of thousands of volts without failure.

In 1932, the introduction of chlorinated aeromatic hydrocarbon impregnating compounds (Askarels or PCBs) allowed the electrical industry to use this material because of its high dielectric capabilities, and its important heat-resistant properties that made it nonflammable. Since then, PCBs served for years as a successful fire-resistant transformer and capacitor coolant and insulator.

Most of the transformers used in the United States use mineral oil as an insulating and cooling medium. However, mineral oils have one serious drawback, they are flammable. Where transformer failures may cause fires and explosions threatening life and property, the use of mineral oil is restricted. Fire underwriters will not allow the use of flammable liquids for transformers located indoors, in congested areas, large buildings such as the World Trade Building, Sears Tower, hospitals, schools, or homes. In these instances, the transformer is filled with a nonflammable PCB.

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In every instance, the transformer and/or the capacitor must have the ability to conduct the current and to insulate parts of the equipment from the alternating current. This ability to insulate portions of itself from the alternating current is called the dielectric strength.

Today, capacitors are widely dispersed throughout our total environment. Capacitors are located on power lines, in factories, in buildings and in our own homes. The insulation system of every alternating-current capacitor employ PCBs to prevent the saturated paper, film and aluminum conductor from becoming a hazard if the capacitor fails. It has been the industry's experience that capacitors generally have less life than a transformer. Transformers generally last from 20 to 30 years. Depending on its application, capacitors last from 5 to 12 years.

A more detailed discussion of the properties required of a capacitor dielectric fluid will be discussed later when we talk about substitutes.

In summary then, we can see that the present proposal to eliminate PCBs from the environment will have a direct bearing on the use of all alternating-current capacitors in the U.S. and on the use of transformers in high-risk areas. So, polychlorinated biphenyls have found acceptance in our electrical systems since they provide safety to the consuming public and to workers in industry. In addition, this electrical equipment permits our country to manage all of its energy sources efficiently. If PCBs are eliminated without suitable alternates, energy use in this country, would climb by approximately 10 percent. This energy increase will cost the consumer of electricity $100 million a week.

Since 1972, the use of PCBs in other areas has been discontinued so that presently transformers and capacitors represent the only application for these chemicals. Recently, it has been proposed that PCB mixtures be eliminated in our electrical equipment as well. The next speaker will show you a capacitor, demonstrate flammability and investigate various alternate measures which are being tested for phasing out or substitution.

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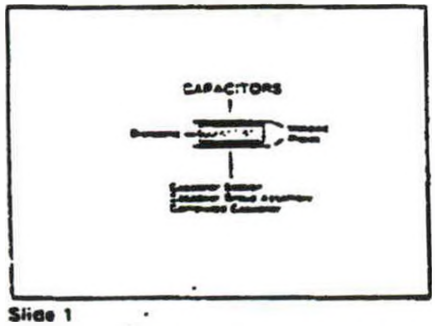
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Power Capacitors

by
J. B. Brittain, Manager
Engineering
Distribution Apparatus Division
Westinghouse Electric Corporation
Bloomington, Indiana

I will talk for a few minutes about three aspects of power capacitors. First, what a power capacitor is and how they are manufactured. Next, a discussion of what a PCB is, and last, some alternates to PCBs.

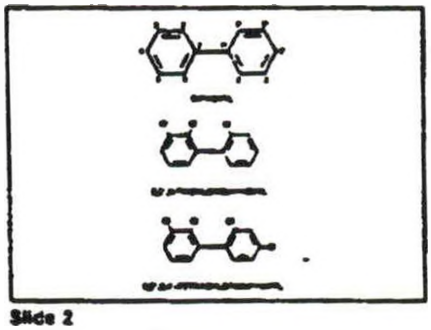


Slide 1

For a few moments, I would like to take you back to your days of high school physics (Slide 1). A capacitor is usually represented as shown on this slide. All capacitors consist of two metallic plates one on each side of an insulator which is known as a dielectric. In the capacitors manufactured here, the two metallic plates are thin aluminum foil, and the dielectric is a high grade of kraft paper and polypropylene film. These elements are wound into sections similar to the one shown here. They are then banded together into groups of sections. The individual sections are then connected together for the proper voltage rating and placed inside a stainless steel can. The two bushings located on top, are there to bring the electrical connection to the outside of the can. The dry capacitor in a can, such as this, is placed inside of a vacuum impregnator. This is a large chamber about one-half the size of this room. The impregnator can be heated, and a high degree of vacuum is applied to it. For several days alternate cycles of vacuum, and heat, are applied to remove all the moisture from the material. The tightly sealed impregnator is then flooded, and the capacitor is filled with PCB. The stainless steel can is sealed, and the capacitor is complete.

Everyone these days seems to be discussing PCBs. I would like to take a few minutes now and explain what a PCB is and point out the fact that there are different kinds of PCBs.

As mentioned, PCB stands for Polychlorinated Biphenyl. This beaker contains a PCB. It looks and feels like any good grade of highly refined oil.

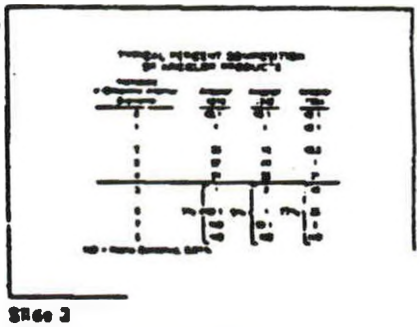


Slide 2

In order to illustrate what a PCB is, I will again have to take you back to your high school days, this time in chemistry.

The first diagram illustrates a benzene molecule. It is a six-sided carbon ring with a hydrogen atom attached at each of the corners. If by chemical process, two of these benzene rings are joined together, we obtain what is called a biphenyl molecule. Again by chemical treatment, we can replace one of the hydrogen atoms by a chlorine atom. This then makes a mono-chlorinated biphenyl. If we replace another hydrogen atom by a chlorine atom, we obtain a di-chlorinated biphenyl. In this stage, the compound could also be referred to as a polychlorinated biphenyl, or a PCB. Chlorine atoms can be added to these rings at different places and in various combinations. Each one of the compounds formed is called an isomer of a polychlorinated biphenyl. There are 209 such isomers. My purpose in developing a PCB in this way is to give you a concept of how a PCB is made and to demonstrate the fact that all PCBs are not the same.

Environmentally, our concern is whether or not PCBs are biodegradable. Biodegradability is related to the number of chlorine atoms, or the amount of chlorination of the biphenyl compound.



Slide 3

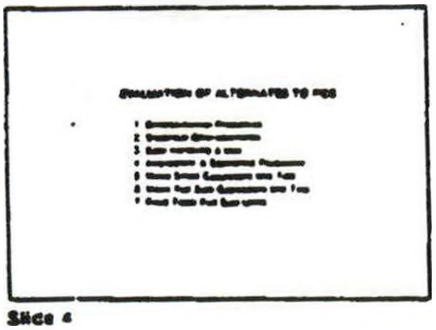
For example, biphenyls with five chlorine atoms and above are the most nonbiodegradable. Monsanto, who is the only manufacturer of biphenyls in the United States, designate their compounds by number as shown on this slide. Note that the compound called 1254 which was used in capacitors until the mid-fifties, has a percent of pentachlorinated bionenyls and higher isomers of 77 percent. 1242 which succeeded 1254 contains only 9 percent of the pentachlorinated biphenyls and higher isomers. When the question of PCBs in the environment surfaced the latter part of the 1960s and early 1970s, Monsanto developed a new liquid which they designated as

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1016. 1016 greatly reduced the amount of the higher chlorinated molecules. Note that 1016 contains only one percent of pentachlorinated biphenyls and higher isomers. In other words, the PCB that we use contains 99 percent of the more biodegradable isomers. We started using this material in capacitors the moment it became available. Also, steps were taken to reduce the amount of PCBs escaping from the plant. This will be discussed later by Mr. Sawyer. Mr. Kerns will discuss some of the environmental relationships of these compounds.

What are Alternates to PCBs



Slide 4

PCBs were introduced in 1929 and presently no one has developed a fluid that has all the desirable properties of PCBs for making a power capacitor. With 40 years of experience in capacitors, Westinghouse has evaluated alternate fluids, as shown on this slide.

In scrutinizing the various possible fluids to design and produce a good capacitor, we were extremely sensitive in selecting a fluid that had no environmental problems. A prime characteristic of the fluid is that it must make a reliable long-lasting capacitor, and the failure rate must be low. Any fluid selected must be capable of being handled with minimum danger to employes. Another most important consideration is that the capacitor must be safe in performing its function. The fluid must be readily available and it must have reasonable cost.

After a number of tentative fluids are selected, we then make a small capacitor similar to the type that is in your home air conditioner (Exhibit R&D Capacitor). These are run under accelerated test conditions to evaluate failure rate, life, etc. After one or two candidate fluids demonstrate the best properties, we then make full-size capacitors and run them on accelerated tests. If tests are successful, we then build a number of units and install them on our customer's systems. With our customer's cooperation we then evaluate the capacitors' performance.

A number of fluids have been found which exhibit all of the requirements previously outlined except for *safety*. There is no known fluid today that will make a good capacitor, containing the fire-resistant properties of PCBs. A number of alternate fluids have been proposed by Monsanto, Dow Chemical, Shizuki in Japan, the General Electric Company, the Sun Oil Company, and others. Some of these will make better capacitors than others. Some are more readily available than others. Some are more economical than others. But, the one key drawback is that not one of them are as fire resistant as PCB. Our care for safety is the primary reason that we have not switched to a fluid other than PCBs by now.

In 1974 we settled upon an alternate fluid which we designated as F982. This fluid had competitive flammability characteristics but did not have the excellent flammability characteristics of a PCB. We decided, however, that if PCBs were eliminated and we had to go to an alternate fluid, that we would use this fluid in spite of its poorer flammability characteristics. We reached a point in the development schedule and built units for customer field testing. After another review of the handling of this fluid in a large quantity, we decided that because of safety we did not want to expose our workers to the fluid.

You must remember that at this point, we had around one-quarter of a million dollars invested in this alternate fluid. We then renewed our search for a fluid. Today we have settled on another fluid, safer to handle, but with inferior flammability characteristics than PCBs. We have designated this fluid S17 and are presently constructing capacitors for field tests. We have spent over one-half million dollars in arriving at this point.

I have talked about the difference in flammability between PCBs and all alternate fluids. I would now like to demonstrae this difference. If I take a piece of the tissue paper fro which a capacitor is made, fold it a saturate it with the liquid being tested, and then strike a match to the PCB will flare up and start to burn. However, it will immediately go out. If we take any other known alternate fluid today, and make a similar test, the paper and the flu will continue to burn until it is all consumed.

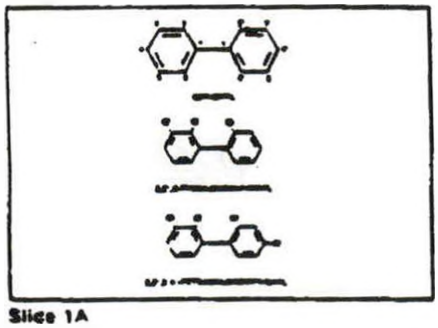
Now, what does this mean to yo and to the public in general. In you own home, if you have a window a conditioner or a central air conditioner, it probably contains a sma capacitor made out of PCBs. Your washing machine also probably contains a capacitor made with PCBs. Your furnace may have a capacitor containing PCBs. If you have some fluorescent lights, they probably contain a capacitor with PCBs. Your television set will probably contain a capacitor made with PCBs. Yet, I would say that no one in this room has ever known of a fire caused when one of those capacitors failed. If the capacitor industry switched to the only alternate fluids known today, when one of those capacitors fail, they could very well start a fire. Today, the entire capacitor industry would like to discontinue the use of PCBs because of environmental concerns. However, the potential fire hazard in homes, schools, hospitals, and businesses could well be more serious than the problem we are trying to correct.

I hope this will give you a little better idea of what a PCB is and how we use them in this plant and in the capacitor industry.

CONFIDENTIAL

Environmental Relationships of PCB Compounds

by
B. A. Kerns, Manager
Environmental Control
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania



Slide 1A

As you have already heard today, there are 209 possible homologs of PCBs. The mixtures of PCBs used t ne electrical distribution equipment industry for the past forty-five years include Aroclor 1260, 1254, 1242, and 1016. Presently Westinghouse uses only Aroclor 1016 for capacitors and Aroclor 1242 for transformers. The basic differences in these materials is in the degree of chlorination. For example:

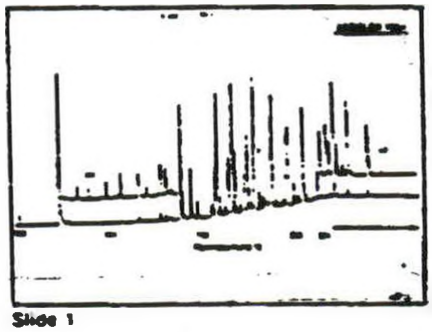
1. Aroclor 1254 contains 54 percent by weight chlorine and is primarily 77 percent five chlorine atoms and higher.
2. Aroclor 1242 has 42 percent chlorine and is only 8 percent five chlorine atoms and higher.
3. Aroclor 1016 contains 41 percent chlorine and is only one percent five chlorine atoms and higher.

For the polychlorinated-biphenyl materials, the level of chlorination appears to be the most significant factor in their relative biodegradability. The rate of biodegradability de reases as the number of chlorine at ms per biphenyl molecule increases. Chromatograms (which I'll explain in a minute) representing samples after exposure to activated sludge (as used for example in the City of Bloomington sewage treatment plant) show significant alterations in the Aroclor 1016 distribution but little for Aroclor 1254.

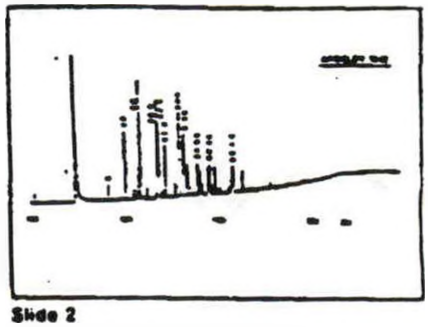
Passage of PCBs through activated sludge has shown that 33 percent of Aroclor 1016 degrades per forty-eight-hour cycle with a semi-continuous treatment method. This compares favorably, since 25 percent of Aroclor 1242 degrades in forty-eight hours, and 15 percent of Aroclor 1254 degraces in forty-eight hours. Results of additional tests with Aroclor 1016 showed that treatment for fourteen days reduces the various mixtures in 1016 from 17 to more than 98 percent. More on this later.

These tests have led to the conclusion that Aroclor 1016 is sufficiently biodegradable to remain in controlled usage.

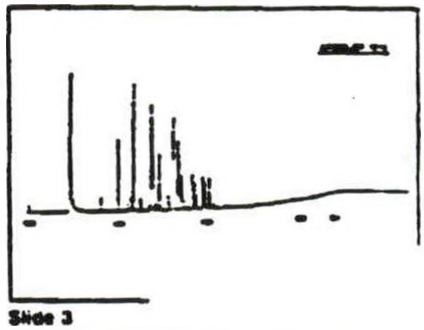
Most analytical data for PCBs utilize chromotography. This is a device to analyze a micro-sample of the material which is injected into a column or coil of tubing under controlled conditions of temperature, injection rate and volume. The heated column selectively releases each isomer. The release is recorded on a chart. Slide 1, 2 and 3 show typical charts or chromotograms for Aroclor 1016, 1242 and 1254. The horizontal axis indicates time while the vertical axis represents the amount present. The total amount of PCBs present is determined by integrating or measuring the area under the curves. You will note that while Aroclor 1016 and 1242 exhibit similar retention times, Aroclor 1254 shows a much greater retention time due to its higher chlorination and higher molecular weight. Slide No 4 shows the small differences between 1016 and 1242. Note additional peaks from time 70 on 1242 also showing some higher chlorination and higher molecular weight.



Slide 1



Slide 2



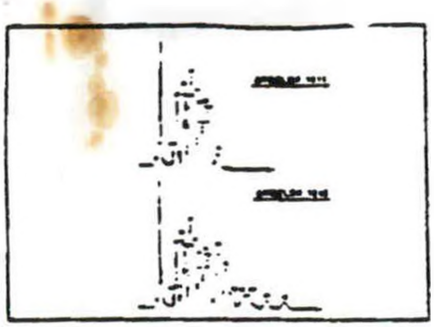
Slide 3

These data on degradation plus the complexity experienced developing analytical tools to correctly identify and quantify the mixtures of PCBs used within our own plants led us to conclude that many of the agencies supervising PCB analyses are arriving at erroneous results

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Slide 4

For example, analytical data provided to Westinghouse by agencies in Indiana show amounts of Aroclor 1016 in waters and in fish which could not possibly be there from degradation. In addition, the analyses for PCBs in fish used the whole fish. More commonly, however, only the edible portions are analyzed, allowing a correction factor of about four. In other words, the amount of PCBs in the whole fish should be divided by four to arrive at the concentration in the edible portion.

It seems incongruous that PCB standards are being imposed using as background information an analytical technique which was nonexistent five years ago and is presently, at best, questionable. An analytical technique which stretches technology to the limit and shows error ranges up to plus or minus 50 percent. How can reasonable replies to these important questions be answered, using inaccurate and/or nonexistent data.

In November, 1975, the EPA held a conference on PCBs in Chicago. At this meeting, many papers were presented on research studies, under EPA supervision and support, to determine the effect of PCBs on fish and animals. It was unfortunate that practically all experiments, at that time, were conducted using Aroclor 1254. This material has not been used in Westinghouse transformers since 1968; because of its nonbiodegradability and its possible detrimental effects on the environment. Importantly, Aroclor 1254 has never been used in the Bloomington plant. While a few screening studies were carried out by EPA on Aroclor 1242, no studies on the use of Aroclor 1016 had been planned at that time.

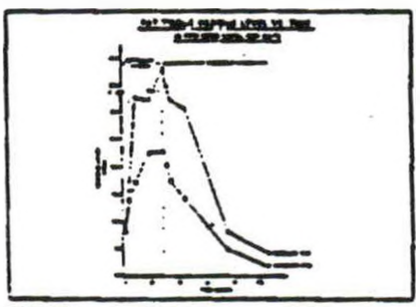
In addition, most of the data reported at this meeting indicated that massive doses of PCBs (not even available for the last two or three years—1248, etc.) given to rats and monkeys had detrimental effects. However, little work was carried out using concentrations as found in the environment. Another critical factor, often overlooked, is that residual PCB levels in the fat tissues of animals do decrease rapidly, following the cessation of exposure to PCBs (See slide No.6).



Slide 5

Fish found to contain the highest levels of PCBs were the bottom dwelling scavengers such as catfish, carp and eel. The game fish showed much lower levels. Factually, in surveys carried out between 1973 and 1975 in Lake Michigan, the number of fish found to contain PCBs decreased. Moreover, we are unaware of any study to measure PCB content in fish after cooking. Cooking should remove fat and fat containing PCBs from edible fish.

Presently EPA has agreed to carry out studies on the effects of Aroclors 1016 and 1242. These data should be available within 12 to 18 months. We feel that these studies will show a dramatically reduced environmental effect from these lower homologs—effects that allow a timely and orderly conversion to other dielectric fluids that will not cause severe penalties in safety and energy use.



Slide 6

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Manufacturing

by

R. B. Sawyer, Manager
Manufacturing Planning
Distribution Apparatus Division
Westinghouse Electric Corporation
Bloomington, Indiana

The approach taken to reduce discharges of Aroclor into the environment has been to abate the amount of Aroclor that would come into contact with water. In the late sixties and early seventies, when the potential problem was identified, there was no demonstrated technology, or means, to remove the very small amounts of Aroclor that might be contained in the water. Because of this, we addressed ourselves to the task of reviewing our manufacturing procedures to determine what actions should be taken to prevent [illegible] contact with water. Let me explain what we have done.

We use relatively large quantities of this material, from 75,000 to 150,000 gallons per year, depending upon the number and size of capacitor units made. Our first concern was to make sure that large quantities could not escape into the environment. I wish to explain to you how we handle and use this material in our operation.

The fluid is received in 8,000-gallon railroad tank cars. When the tank car arrives, the fluid is pumped into two large storage tanks located on the outside of the plant. To make sure that the fluid could not escape, in the remote event that a tank ruptured, we built a concrete dike around the storage tanks.

Then, the Aroclor is pumped from the storage tanks to treatment equipment inside the plant. Here we remove any minute particles that might contaminate the fluid. After treatment, the pure fluid is pumped in[illegible] six storage tanks above the impregnators. To make sure that none of this material escapes (in the event of an accident, or tank rupture), we sealed all the floor drains in this area. Large quantities of Aroclor cannot escape into the sanitary or storm sewer.

Now then, the assembled capacitor units are placed inside vacuum chambers to remove all the air and moisture from the units, as discussed by Mr. Brittain. These chambers are about 4 feet wide, 5 feet high, and 30 feet long. These impregnators are completely sealed and under vacuum. After removing the moisture and air, each vacuum chamber is filled with fluid from the overhead storage tanks. The fluid flows into the top of the capacitor and completely fills the unit with Aroclor. This is allowed to soak awhile, and then the excess Aroclor is pumped from the chambers into another group of storage tanks. The excess is pumped back through the purifiers and back up into the pure storage tanks. The floor drains in this entire area are sealed off.

The capacitors are removed from the ovens and placed on roller conveyors. Under the roller conveyors drip trays were installed to catch the fluid that dripped off the outside of the capacitor can. We also put floor dry or sawdust under the drip trays to soak up any fluid that might get through these trays. This will be discussed later. The fill hole on top of the capacitor is sealed by means of a plug and solder.

At this point in the manufacturing cycle, we are faced with two situations:

1. The inside walls of the vacuum chambers have a film of Aroclor on them.
2. The outside of the capacitor has film of Aroclor that must be removed prior to painting.

Part of the vacuum cycle in the vacuum chambers is done with pumps that use water as a seal. As the chambers are heated up, the film of fluid on the wall vaporizes, goes into the pumps, condenses in the water which runs into the sanitary sewer. The capacitor units are hung on an overhead conveyor system which takes the units through a water and soap washing machine—something like a car wash. The rinse water, which contains some of the film of fluid that was on the outside of the can, flows into the sanitary sewer.

As stated earlier, we know of no way to remove the Aroclor from water. So, in 1970 we started looking at the various alternatives that would prevent the Aroclor from making contact with the water. In other words, we needed to keep the ovens dry, or trap the vapors prior to water contact. Moreover, we needed to keep the outside of the capacitors dry, or find a different way to clean the capacitors. We concluded that the ideal way was to keep the fluid in a sealed/plumbers delight/system—don't let it make contact with the oven walls or the outside of the capacitor can. We identified a way to accomplish this and called it the manifold fill system. The assembled capacitors are put in dry vacuum ovens to remove the water from the capacitor unit. Then the capacitor units are removed from the oven. Each unit is connected with a sealed hose connection. A vacuum is pumped on each unit to remove the air. Then the unit is filled through this hose connection.

We spent a quarter of a million dollars on this project. Some modifications were made to improve the operation, and we had some minor cleanup to do. Good progress was made in reducing our small dis-

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charges. By later 1974, we had [illegible] 95 percent of our production on the manifold fill process.

Quite to our dismay, in late 1974 and early 1975, reports from the field indicated a very serious quality problem. Units filled by the manifold filling process were failing in service at nearly twice the failure rate of flooded units. Worse yet, many of the failures were catastrophic. That is, some cans were rupturing when they failed and, consequently, releasing more Aroclor into the environment. We investigated the problem and concluded that it was possible to have minute pockets of air or vapor inside a capacitor section when it was processed with this system. When this happened and when the unit was in service for a few months, the film and paper would break down wherever there may be air or vapor pockets.

Certainly, customers could not and would not tolerate this excessive failure rate, nor could they tolerate the excessive catastrophic rupture failures with attendant risks to people. As a reliable supplier, we did not want this situation and did not want PCBs entering the environment upon failure. We returned to the proven method of flooding the units under a vacuum in the chambers.

In mid-1971, we changed fluids from Aroclor 1242 to Aroclor 1016. The significance of this change was covered by Mr. Kerns.

In 1970 and 1971, we reviewed our practices on waste disposal. In our manufacturing process, we generate some liquid waste—Aroclor from the drip trays that is so contaminated with impurities that we cannot clean it up. Pump oils also become contaminated with the Aroclor. In addition, floor dry, sawdust, paper towels, solid waste from the purifier, etc., pick up Aroclor in the filling area. Further, we have some units that fail on final-testing operations. We have not been able to repair many of these failed units, and we have not been able to reclaim the highly contaminated Aroclor. Prior to 1971, these wastes were placed in local landfills. This was a potential problem. Therefore, since 1971, our liquid wastes have been shipped to companies that have approved thermal oxidation incinerators designed for this material. Also we have shipped solid wastes, failed capacitors, saw dust, etc., to scientific landfills. Landfills that are designed and controlled to handle unique wastes of this type.

Our customers have been advised by instructions to the field and with nameplates on the capacitors that the users of these capacitors needed to take the same precautions in disposing of failed and/or obsolete units.

Professional people from our plant shared this knowledge and experience with other manufacturers and users. Mr. Wills will be telling you of our work in establishing voluntary standards for handling PCBs.

Over the years, we have invested research and development time and money to improve capacitor designs and manufacturing technologies. The object was and is to use less and less Aroclor to produce capacitor units and still maintain an equivalent performance.

Let's review what has happened since 1970. At the start of 1970, we were producing capacitor units, called Mark I series. During 1970, we introduced the Mark II series of capacitor units. These units used 42 percent less Aroclor than used in the Mark I. In 1973, we introduced the Mark III and Mark IV series. These units required 25 percent less Aroclor than used in the Mark II units. In June of this year, we will introduce the Mark V series. The Mark V will use approximately 20 percent less material than used in the Mark IV. Significantly over a six-year period we reduced the amount of Aroclor per capacitor rating by 66 percent.

We are now faced with the problem of discharges from the water seal pumps and from the washer. Our first attempt to correct this problem failed. However, we are working on the problem and again reviewing the alternatives, and will take another approach—hopefully, with considerably more success than the last attempt.

Our basic objective is to prevent the Aroclor from coming into contact with the water. We will be exploring new technology some of which may have been proven in a laboratory environment, but may not have been proven in a production environment. In any event, we expect to reduce discharges, but will not happen overnight. As our plans are formulated, we will be reviewing them with the appropriate agencies. Others will be kept advised of our progress in technology. We will remain constantly alert to techniques others might develop to improve our own processing.

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Voluntary and Regulatory Control

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by
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Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

At the present time the use and control of PCBs has resulted from voluntary actions by industry. After four years under the Federal Water Pollution Control Act Amendment (FWPCA) of 1972, the U.S. EPA has not established justifiable standards for the discharge of PCBs based upon an adequate basis. I will set forth the activities Westinghouse and the electrical manufacturing industry have taken since 1970. After which I will review these actions taken by governmental bodies as they relate to PCBs.

The accumulation of proof, in 19[illegible] indicated that uncontrolled industrial applications of polychlorinated biphenyl compounds (PCBs) was contaminating the environment. Consequently, in the absence of federal and state action, industry was required to begin appropriate restraints. The single domestic supplier of PCBs restricted sales for use in only "closed-system" electrical applications, such as the capacitor demonstrated here. This voluntary effort removed approximately 40 percent of the PCBs used in the United States.

Additionally, manufacturers initiated specific control measures that Mr. Sawyer covered. However, to strengthen and supplement these control measures, the electrical industry, through the National Electrical Manufacturers Association (NEMA), started to develop standards and guides to prevent the inadvertent loss of PCBs to the environment. NEMA appropriately included all stages from initial manufacture of PCBs to ultimate disposals. This work resulted in an industry document Official Standard Proposal which was published January 25, 1973.

Guidelines for plant housekeeping, bulk fluid shipment, receiving and transfer, employe safety, control of water effluent, labeling and scrap disposal procedures are significant areas covered by the Official Standard Proposal. Further, the guide listed known facilities with capability to incinerate PCBs, or to maintain a regulated chemical and scientific landfill area.

Furthermore, the proposal recommended that PCBs used in capacitors should consist of homologs and isomers of chlorinated biphenyl with a low concentration of the higher chlorinated homologs, Aroclor 1016. These guidelines were formally adopted in January, 1974, as an American National Standards Institute (ANSI) of standards. On April 1, 1976, the U.S. EPA published a notice of recommended disposal procedures that are substantially in accordance with the ANSI guidelines. Unfortunately, the EPA did not indicate that this guidance had already been furnished to the industrial community on their own initiative.

Westinghouse also established preventive measures in handling and storage of new and scrap PCBs to prevent and/or control accidental spills of PCBs. These techniques are similar to those that have become requirements for oil under the provisions of Section 311 of the Federal Water Pollution Control Act Amendments of 1972. We have recently reviewed and updated these procedures, and they will probably not require substantial modification when EPA finally announces regulations for the control and containment of hazardous substances.

The EPA has also attempted to develop regulations that would control the discharges of polychlorinated biphenyls under the provisions of Section 307(a) of the Federal Water Pollution Act Amendments of 1972. This method of control seems to be a proper procedure, because regulations that develop will be based on complete scientific information. It will not subject industry to inconsistent or unrealistic requirements. Thus, on December 27, 1973, the EPA proposed effluent limitations for the control of PCBs. A major problem developed, however, during the course of the hearings.

Section 307(a) of the Act required EPA to establish the basis of the scientific information to justify the limits set. In addition, EPA was to consider the toxicity, the persistence, the biodegradability, the importance of affective organisms, and the effect on organisms, of the pollutant. As discussed by Mr Kerns, PCBs are a class of chemicals whose individual members have widely differing combinations of physical, chemical and biological properties. The published literature clearly showed that the types of Aroclors that contained higher proportions of the five or more chlorine atoms per molecule were more persistent in the environment. The published data also stated that the lower chlorinated isomers were more rapidly metabolized or biodegraded. Therefore, it did not have the same accumulation potential.

However, EPA did not recognize these essential differences and used data related to the higher chlorinated homologs or isomers and some mixtures the electrical industry had terminated 10 years before. In fact, the EPA stated that it did not

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an adequate basis upon which
stringent but reasonable standards
would have carried out the
ises of Section 307(a). There
im no information sub-
t in the "Basis and Purpose"
ment that related to Aroclor
even though manufacturers of
ical capacitors had used this
ved material for more than two
. Thus, at the end of the hearing
ther expert witness from both
had been examined, the pro-
limitations were withdrawed.
during subsecuent litigation,
als of the EPA stated that the
t of the proceeding would not
on their proposed limitations.
te the conclusion of these
gs, the EPA has indicated that
ntend to propose new effluent
ards for PCBs. There is no
tion that they have initiated
ew studies to determine the
ty and biodegradability of
or 1016. They, however, have
ed the course of public state-
to use "public pressure" to
ate PCBs used as dielectric
Only after these public state-
, has EPA begun to collect
tati on the use and need of
n the United States and the
to which they are discharged
e environment.

Food and Drug Administra-
so took action in 1972 to limit
ount of PCBs that may be
ly present in food, resulting
intentional contamination.
erances were established in
973. This provided that the
portion of fish was limited to
centration of 5 ppm. Based
ecent information, the FDA is
ing this tolerance limit and
ed this decision on February
5. However, the FDA also
that:

> Surveillance data gathered
> FDA and the U.S. Depart-
> ent of Agriculture subsequent
> the effective date of the
> porary tolerances...have
> own that, with the exception
> certain fresh water fish, the
> ser of PCBs in those
> cts subject to the tolerances
> tinues to be sporatic, and
> at there has been an overall
> substantial decline in
> quency and levels. These
> data further show that the
> average daily dietary intake of
> PCBs is quite low and well
> within the margin of safety."
> (41 Fed. Reg. 8409, Feb. 26,
> 1976)

The States of Michigan and Indiana have taken action to eliminate PCBs from items, products or materials used in these states. Although Monsanto's ban in 1971 was voluntary, there was nothing to prevent some individuals from obtaining these compounds from overseas suppliers. Hence, these laws will effectively limit through a sliding scale of prohibition of PCB content over the next three years. Nevertheless, they recognize, as did the Interdepartmental Task Force on PCBs in 1972, that PCBs used in the electrical equipment industry continues to be indispensable. Accordingly, an exemption was provided for their use in a closed system as the dielectric fluid for an electrical transformer or capacitor. This exemption is to continue until it is documented that there are available substitutes to meet performance standards and environmental acceptance.

Westinghouse concurred with the Indiana proposal since it provides for statutory control over the use of PCBs in nonelectrical uses. It recognizes that substitutes must be available to minimize the risk of fire and explosion and the disruption of electrical service that might result if PCBs were banned before alternatives were found. Also, Monsanto has publicly stated that they will cease the manufacture of PCBs when there are adequate substitutes. Westinghouse and the entire capacitor industry will be willing to work with the Indiana Board of Health to implement this law as we have with the Underwriters Laboratory, Consumer Product Safety Commission, the Department of Commerce, and the Federal Energy Administration with respect to the welfare of the general public.

The electrical industry and Monsanto have taken the lead in reducing the amount of PCBs that may enter into the environment. These decisions have been based upon the criteria that have eventually become statutory requirements and have not resulted in subjecting the general public to increased risks of fire. In addition, these actions have not deprived the general public of energy during this period of energy conservation.

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Suggested Response to Notice of PCB Spill:

Scope: Establish fast response to notice of major spill of PCB (Aroclor/Inerteen); outline action to notify authorities; indicate methods of containment; establish standard, basic information for use by those concerned; act to minimize costs, liability, loss of material.

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A. Incoming notice of spill to be directed to

1) R. D. McClain - (812) 332-4421, Extension 273
or (812) 332-5056 (Home)

2) R. B. Sawyer - (812) 332-4421, Extension 220
or (812) 332-7461 (Home)

3) A. J. Fink - (812) 332-4421, Extension 298
or (812) 332-5775, (Home)

B. Notice of spill will be provided by telephone (by one of the above 3 persons) to the following:

1) Monsanto (618) 271-5835
and Bill Moore, Akron

2) Indiana Stream Pollution Control Board
(317) 633-4420
or (317) 633-5369
or (317) 633-4360 (after hours)

Immediately, whenever possible, notify the nearest downstream water user.

3) E.P.A.

a) If spill is North of U.S. Highway #40,
Chicago (312) 353-6188
or (312) 353-5638

b) If spill is South of U.S.Highway #40,
Evansville (812) 423-6871, Extension 265
[same for Illinois]

4) Illinois

5) Westinghouse

a) Gateway - Roger Wills, Attorney: WIN 8-235-5815
L.D.
Home

Alternate:

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(b) Bloomington - D.A.D.
- D. M. Sauter, Plant Manager - 332-0095
- D. Williams, Manager of Manufacturing -339-0611
- J. Brittain, Manager of Engineering - 332-5622
- J. L. Shoaff, Matls & Stds. Engineer - 876-5207
- G. E. Mercier, Capacitor Engrg. Manager - 336-3880
- N. E. Maguire, Manager of Shipping - 332-7646
- K. Kelly, Purchasing Manager - 332-9666

C. All rail shipments, Sauget, Illinois to Bloomington, are via Illinois Central Railway, over routes indicated on attached map. ("A")

Nearest highway point (town) is circled on attached segment of highway map. ("B" or "C")

Bloomington D.A.D. representative will depart for spill site as soon as possible.

It is understood that the railway will be in charge of wreck salvage. (A booklet from the American Railway Association outlines handling of non-hazardous materials.) Depending on the magnitude of the wreck, one of the following will be in charge:

Large - Superintendent
Medium - Assistant Superintendent
Small - Local Trainmaster ("D")

Assistance to be rendered will be in the nature of providing information as to identification of the material, precautions to be followed, the urgent need to control and contain the spill, and possible means for disposal.

a) Nature of material: See label on car. (Copy attached) ("E") See attached extract from ANSI C-107. See industrial hygiene excerpts from C-107. ("F")

b) CAUTION: DO NOT FLUSH SPILL WITH WATER.

DO NOT INCINERATE OR BURN IN THE OPEN ATMOSPHERE.

EXTINGUISH ANY FLAMES WITH DRY TYPE FIRE EXTINGUISHERS

c) Contain spills onto open ground with earth dikes or with absorbent material such as OIL DRY, SAND, SAWDUST, etc., or soil which can be recollected for future disposal.

Drain off fluid remaining in tank car into sealed drums.

d) Note that fluid is heavier than water and is almost completely insoluble.

Spills into shallow, still water, or slow moving water, may be

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contained with suitable dikes allowing surface clear water to overflow if necessary. Pump or sluice out contaminating fluid from bottom.

e) PCB fluids and contaminated materials may be disposed by placing in sealed drums. Shipment, to disposal site (Monsanto or Chemtrol), will be arranged subsequently.

Visitation to the site by Indiana Stream Control Board Representative should be expected (in Indiana), to review action being taken, and possibly to make suggestions or to offer instructions. (If instructions are not followed, Westinghouse may become liable for the consequences.) ("G")

D. Information to the press: Inquiries from the press or other news media are to be referred to _____.

E. Indiana State Board of Health regulation SPC-16 requires 5 steps to be completed on notice of spill (See excerpt from Indiana Environmental Health Action, attached). Submission of a complete report may be required by the Indiana Stream Pollution Control Board Technical Secretary.

F. Notice of lesser spills may require part, or all, of the actions above:

Possible "medium" spills can result during shipment of waste to Chemtrol for disposal. Such spills can involve other authorities (than Illinois or Indiana).

A card of minimum instructions (similar to that of Monsanto's on the tank car) is to be provided to the driver on each shipment. (See attached). ("H")

G. Spills from apparatus enroute to a customer are likely, but smaller in potential magnitude.

"Spill Control Instructions" attached.

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SPILL CONTROL INSTRUCTIONS

FOR CAPACITORS BEING SHIPPED

1) Put information on bill of lading and each shipment with instructions to the shippers and to the recipient.

2) If the spill is while the product is in transit, notification will be received by D.A.D. Shipping. Shipping notify McClain, Fink, or Sawyer.

3) If it is a limited incident in transit (a few units) Shipping will give the following instructions:
   a) Return product to Bloomington or the nearest Apparatus Repair Shop with proper protection.
   b) How to clean truck, dock, etc. and dispose of waste material.

4) When the product is returned to Bloomington, an RMR number will be requested and then the normal RMR procedure will apply. If it is delivered to an ARP then a Service Order must be entered by the District Office for the repair. Bloomington must insure that the ARP has instructions for proper handling and disposal.

5) If it is a major incident (truck wreck or many units) notification will again be to D.A.D. Shipping.

6) If the description of the severity warrants it, a D.A.D. representative will be sent to the site immediately.

7) D.A.D. will give information immediately to the shipper on how to contain spills, clean up afterwards and then dispose of waste material.

8) The product should be protected against further spillage and returned to Bloomington or sent to an ARP for repair. Either the RMR procedure or Service Order will apply as appropriate.

9) If the product has been delivered and is on the customer's site, notification will most likely be through the appropriate District Office (either Sales or Service). Care must be taken to insure that the customer recognizes that the clean-up and disposal are his problems. We can offer advice and give recommended techniques.

10) Repair will be accomplished through the carrier claim route with the site chosen after a survey of the problems. It may be any one of the following:

A. Repaired on customer's site.

B. Sent to ARP.

C. Returned to Bloomington.

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OFFICIAL STANDARDS PROPOSAL

THIS OFFICIAL STANDARDS PROPOSAL IS AN OFFICIAL DRAFT OF A PROPOSED STANDARD DEVELOPED WITHIN NEMA, OR IN COOPERATION WITH OTHER INTERESTED ORGANIZATIONS, FOR CONSIDERATION BY ORGANIZATIONS OUTSIDE OF NEMA

SECTION 1
PREFACE

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I. GENERAL

Askarels consisting of or containing polychlorinated biphenyls (PCB's) have been used in many applications for over forty years, but only recently was evidence discovered that PCB's are widely dispersed in the environment. Systematic investigations of the biological effects of PCB's have been undertaken within the past few years to establish the effects of specific formulations upon specific species. Some studies have shown that PCB's may be an environmental contaminant. Simultaneously, significant steps have been taken by U.S. industry to limit further releases of PCB's to the environment.

PCB's have been used in three broad types of applications for the past forty years, as follows: (a) "open ended" applications, for example, in paints, specialty inks, paper coatings, plastics, etc., (b) "nominally closed" applications, for example, as the working fluid in hydraulic or heat transfer systems; and (c) "closed electrical system" applications, specifically as the insulating fluid in certain types of transformers and capacitors. The Monsanto Company is the sole U.S. producer of PCB's. It has discontinued supplying the material for all type (a) and (b) applications.

Evaluations of the alternatives and risk/benefits involved in the continued use of PCB's in closed electrical systems are summarized in the following.

II. BENEFITS

Askarel-filled transformers do not burn or sustain fire under conditions of internal electrical arcing.

Askarel-filled power and industrial capacitors are significantly smaller, more reliable, more durable, and safer than oil-filled capacitors. As a result, askarels have supplanted mineral oils in more than 90 percent of the power and industrial capacitors made today. Over the past few decades most of the equipment that incorporates such capacitors has been designed to take particular advantage of the size, safety and reliability benefits of askarel capacitors (e.g., many types are today less than 14 percent of the size of equivalent oil capacitors and have a life expectancy of ten to more than twenty years).

Various federal, state and local codes, therefore, require their continued use in or adjacent to public, commercial and industrial buildings which locations present the greatest potential danger to life and property.

III. RISKS

In the United States, medical records over a nearly forty-year period show that the only adverse health effects experienced by U.S. workers exposed to askarels, either during the manufacture of these liquids or of electrical equipment containing these liquids, have been limited to occasional cases of non-chronic chloracne or other temporary skin lesions or irritations.

Askarel-filled transformers and capacitors are delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environ-

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ment, transformer failures are limited to approximately 0.02 percent of the units in service per year. With respect to capacitors, such losses are limited to approximately 0.02 percent of the askarel put into service per year. In addition, limited amounts of PCB's can get into the environment during the manufacture, delivery, improper use, maintenance, repair and disposal of transformers and capacitors.

Specific control measures have been instituted by individual manufacturers and are supplemented and strengthened by national standards and procedures such as this Guide which provides information to prevent the inadvertent loss of PCB's to the environment at all stages from initial askarel manufacture through ultimate disposal.

IV. ALTERNATIVES

For technical and local and national code reasons, it would be impossible to replace most askarel-filled transformers now in service with oil-filled units of equivalent ratings, without major construction changes that would be required to compensate for the fire resistance of the askarel-filled units. For certain applications and locations, dry-type transformers may replace askarel-filled transformers.

For new installations, while many of the limitations noted above would still apply, building and installation design provisions could be made to accommodate the use of oil-filled, open dry-type, or sealed dry-type transformers provided necessary technical, code, physical size, and cost considerations are properly evaluated.

The principal alternative to askarels for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1932 level and would necessitate the redesign and replacement of such widely used equipment as fluorescent light fixtures and racks for power and induction heating capacitors, which could not now accommodate the increased size of oil capacitors while maintaining their present ratings.

The cost of askarel liquids is about five to ten times more than mineral oil. Thus, long before there were any environmental concerns about PCB's, there was a strong economic incentive to find other less expensive insulating liquids with the desirable characteristics of askarels. Since the 1930's at least ten major chemical or electrical companies have invested large amounts of time and money in this search, all with no success. While potential substitutes that are most costly than askarels have also received some consideration (e.g., fluorinated liquids), little is known about either their electrical performance or possible ill effects upon the environment. There are today no fluids that can be used as a direct replacement for askarels.

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V. INTERDEPARTMENTAL TASK FORCE ON PCB's

An in-depth study of PCB's has recently been completed by five Executive Branch Departments of the federal government. This Interdepartmental Task Force on PCB's issued their report entitled Polychlorinated Biphenyls and the Environment in May, 1972.* See Section 1 Page 3 for the conclusion quoted from page 4 of this report.

* Distributed by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Price $0.65.

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Table 1
Typical Properties of Aroclor 1016

Property and Method	Typical Values
Color (APHA)	40, max.
Condition	Clear
Specific Gravity at 25/15.5°C (ASTM D 1810)	1.362-1.372
Acidity (mg. KOH/g.) (ASTM D 974, D 664)	0.010 max.
Moisture	35 ppm, max.
Refractive Index at 25°C (ASTM D 1817)	1.6215-1.6235
Inorganic (Free) Chlorides (ASTM D 1821)	0.05 ppm, max.
Pour Point (ASTM D 97)	-14°C or lower
Dielectric Constant (ASTM D 924) (1000 Hz at 100°C)	4.70-4.90
Resistivity (ASTM D 1169) (500 VDC at 100°C, 0.1-inch Gap.)	500 x 10^9 ohm-cm, min.
Hydrolysis Stability Test (ASTM D 1820) (As Chlorides)	0.5 ppm, max.
Thermal Stability Test (ASTM D 1936) (As Chlorides)	0.4 ppm, max.
Distillation Range (ASTM D 20 Corrected)	
10 percent Distilled by Weight	323°C, min.
90 percent Distilled by Weight	356°C, max.
Higher Boiling Homologs (Monsanto Method T-02302)	0.4 percent, max.
Sulfates (ASTM D 117)	None
Dielectric Strength at 25°C (ASTM D 877)	35 kV, min.
Flash Point, Cleveland Open Cup (ASTM D 92)	338°F, min.
Fire Point	None to Boiling Point
Corrosion Test (6 hours at 210°C with bright aluminum foil)	
Change in Weight of Aluminum	0.0 percent
Viscosity at 100°F (SUS) (ASTM D 88)	71-81
Specific Heat at 25°C	0.30
Coefficient of Expansion (ASTM D 1903)	0.00068 cc/cc/°C
Fixed Chlorine (Carius)	41.3 ± 0.5 percent
Power Factor at 100°C 60 Hz (Monsanto Method T-2273)	
Bulk	1 percent, max.
Drums	4 percent, max.

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SECTION 2
CAPACITOR GUIDELINES

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I. INTRODUCTION

The environmental effects of askarels are under in-depth study by governmental and other agencies. Askarels have been considered relatively harmless to humans based on about forty years of safe industrial usage. There has been no known instance of human injury when they were used under the normally accepted precautions and conditions of handling in both manufacturing and user applications.

Traces of askarels are being found in the environment and in fish and birdlife. The long-term genetic and ecological effects are not yet completely understood. For these reasons, care should be taken to contain askarels and minimize their entry into the environment.

There are two general classes of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their high degree of nonflammability, they are used in transformers where personnel safety is of paramount importance.

Capacitor-grade askarel has a lower degree of chlorination (composed primarily of the 3-chlorine isomers of biphenyl) and a higher degree of biodegradability. Generally, it has not been found in animal life. It is used in capacitors where the extreme degree of nonflammability required in transformers is of less importance.

Although capacitor- and transformer-grade askarels both contain members of the PCB family, they do differ in composition, degree of biodegradability, persistence in nature, electrical stability, chemical stability, and degree of nonflammability (both are recognized as nonflammable). It is for these reasons that this section of the Guidelines is intended to apply to capacitor-grade askarel.

II. CAPACITOR-GRADE ASKAREL

In September of 1971, a new grade of capacitor impregnant, Aroclor 1016, was made available to the industry. This new grade contains a typical concentration of 0.4 percent by weight of the higher boiling homologs of the chlorinated biphenyls. * Aroclor 1016 replaces Aroclor 1242 which previously was the major capacitor impregnant and contained around 7 percent of the higher boiling homologs (the more persistent in nature). This 0.4 percent level of the higher boiling homologs should be the maximum concentration acceptable in any capacitor impregnant. Aroclor 1242 and 1254, previously used as impregnants, do not meet this requirement and should no longer be used in capacitors designed and manufactured for alternating-current applications.

Aroclor 1016 has the same UL nonflammability rating as Aroclor 1242. Its typical properties are given in Table 1. (See Section 2 Page 2.)

III. PLANT HOUSEKEEPING AND EMPLOYEE SAFETY

The following procedures and limits are intended to be minimum requirements to be met by manufacturers and users of capacitors containing askarel. Handling, control and disposal procedures are given, together with exposure limits and indicated antidotes and cleanup procedures.

A. Material

Askarel for use in capacitors should consist of homologs and isomers of chlorinated biphenyl with the concentration of the higher boiling homologs at about 0.4 percent. * Aroclor 1016 is considered to be the standard impregnant meeting these requirements.

* Monsanto Method T-02302.

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Commonly used solvents include benzene, kerosene, acetone, trichloroethane, trichloroethylene and perchloroethylene. Typical vapor pressure data for Aroclor 1016 are:

0°C	=	0.001 mm
25°C	=	0.006 mm
150°C	=	4.3 mm
200°C	=	29.0 mm

At 25°C and 760 mm Hg pressure, saturated air contains approximately 0.09 mg liter.

[1 mg/liter = 90.0 ppm (v/v)]

[1 ppm (v/v) = 0.011 mg/liter]

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B. Bulk Fluid Shipment, Receiving, and Transfer

Shipment of askarel from point of manufacture to point of receiving should be done in closed containers such as rail tank cars, truck tanks, marine or barge tanks, or sealed drums. Containers should be labeled as to contents and carry a label cautioning against loss of fluid to the open environment. Containers used to transport askarel should not be used for storage or to transport other material without being completely cleaned of all traces of askarel. (Cleaning procedures must take cognizance of precautions against excessive exposure and of the need for proper disposal of contaminated cleaning solvents and materials as set forth in Part V of this Section.) Transfer from shipping containers to processing systems should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluid lost by leakage or spills from the transfer system and from the storage containers.

Drums to be retired from use should be cleaned before crushing, delivery to scrap dealers, or other disposal. Contaminated cleaning fluids and materials should be disposed of as indicated in Part V.

C. General Safety Precautions

Although it is generally accepted that exposure to capacitor-grade askarel is not hazardous provided simple precautions are taken, exposure should still be avoided.

1. Vapors—The odor of askarel is noticeable well below the maximum air concentrations considered safe. Up to 1.0 milligram per cubic meter of air has been determined to be the maximum safe level of exposure during an 8-hour work day (Par. G, reference 8). The procedures for performing the necessary analyses are contained in Section 3, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls."

Breathing vapor or fumes from heated askarel should be avoided. Provisions should be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure to askarel (especially at 85°C or higher). The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride, and small percentages of carbon dioxide, carbon monoxide and oxygen. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarel is necessary under emergency conditions, an approved gas mask or self-contained breathing apparatus should be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of an accident. If the odor of askarel is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

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2. Liquid—Unlike insulating oil, there is virtually no fire hazard in handling askarel. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should be such as to minimize or eliminate contact with askarels. Use of eye protection is recommended. The use of porous gloves which can absorb and retain askarels is to be avoided. Barrier creams* or resistant gloves† should be used if contact is unavoidable. Use of enclosed transfer and handling equipment, processing equipment, and mechanical washers reduces direct contact.

Medicinal washes or mild detergents followed by the application of cold cream will reduce the irritation resulting from the contact of an open cut or abrasion with askarel.

Safety glasses with side shields or a face shield should be worn when handling askarels. If liquid askarel contacts the eyes, the eyes should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician. (A drop of castor oil has been found to reduce irritation.)

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under the supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or using toilet facilities.

D. Manufacturing Housekeeping

Manufacturing equipment and operating procedures should safeguard against loss of askarels to the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 55°C. Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all askarel processing areas to ensure against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

Spills of askarel should be removed promptly by means of absorptive material, such as sawdust, or trapped and removed by pumping or other suitable means.

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* For example, PLY No. 9 Gel (Milburn Co., Detroit, Michigan), or Ketodex #71 (Ayers Laboratories, P. O. Box 8236, Church Street Station, New York, N. Y. 10008), or the equivalent.

† Edmont, Solvit [illegible] (Alexsik of Bridgeport, [illegible] Cross Street, Bridgeport, Conn. 06601), or the equivalent

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Waste fluids containing askarel not suitable for reconditioning or reuse should be collected (by means of traps, drip pans, trays, etc.) from the various parts of the manufacturing and processing area (including washers or other cleaning devices). Disposal should be made in accordance with Part V of this section.

Wiper rags, clothing and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled laundering or disposal (see Part V of this section).

E. Disposal of Askarel Wastes

Methods for disposal of liquids and saturated solids generated by the manufacturing operation should be in accordance with those outlined in Part V of this section and should include (but not be limited to) the following wastes:

1. Contaminated liquid askarel which is unsuitable for reclaiming as a dielectric fluid.
2. Liquid askarel from solvent operations or water/detergent type washers.
3. Saturated earth or other absorbent media from filtering operations.
4. Saturated sawdust or other absorptive materials from spills.
5. Saturated filters from vapor control devices and other filters.
6. Saturated wastes (paper, rags, etc.).
7. Saturated, spent gasket materials.
8. Askarel-contaminated vacuum pump oils.
9. Askarel-contaminated steam jet vacuum system condensates.

F. Miscellaneous Procedures

1. Spills by leakage from finished capacitors should be cleaned up promptly by means of absorbent media which should then be moved to containers provided for that purpose within the containment area and later disposed of properly.
2. Askarel wastes should never be disposed of down effluent drains or sewers. The utmost care must be exercised to prevent accidental loss by these avenues to the environment.
3. Capacitors failing tests or otherwise designated for disposal must be controlled and handled in accordance with the intent of the procedures above, finally being disposed of by one of the means outlined in Part V of this section.

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G. References

1. Monsanto Industrial Chemicals Company Technical Bulletin 0-FF/1R, Aroclor® Polychlorinated Polyphenyls (Biphenyls) (November 1971).
2. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. AMA Archieves of Environmental Health 9:545 (1964).
3. Treon, J. F., F. P. Cleveland, J. Cappel, and R. W. Atchley: The Toxicity of the Vapors of Aroclor 1242 and Aroclor 1254. American Industrial Hygiene Association Quarterly 17:204 (1956).
4. Elkins, H. B.: The Chemistry of Industrial Toxicology. John Wiley and Sons, Inc., New York (1959).

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5. Drinker, C.K., M.F. Warren, and G.A. Bennet: The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology 19:283 (1937).

6. Drinker, C.K.: Further Observations on the Possible Systemic Toxicity of Certain of the Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology 21:135 (1939).

7. Greenburg, L., M.R. Mayers, and A.R. Smith: The Systemic Effects Resulting from Exposure to Certain Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology 21:29 (1939).

8. Hygienic Guide Series "Chlorodiphenyls" (January-February 1965) by the American Industrial Hygiene Association, 210 Haddon Avenue, Westmont, N.J. 08108.

IV. CONTROL OF WATER EFFLUENTS

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems in capacitor manufacturing plants are probably contaminated as a result of past practices, and askarel traces may continue to show up in effluent streams for some time. However, the level should continue to decrease with the proper containment of askarel wastes and no further discharges into drain systems. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams and that accidental spills be prevented from getting into such streams.

A. Concentration Limits

The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.

B. Monitoring Streams

On a regular basis consistent with plant situations, all effluent streams should be analyzed. The procedures for performing the necessary analyses are contained in Section 3, Analysis of Water and Sediment for Polychlorinated Biphenyls. This procedure or its equivalent should be used.

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C. Methods for Minimizing Effluent Stream Contamination

The ideal approach is to totally isolate all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant. Carbon adsorption, limestone beds, and solvent extraction are techniques which can be applied to reduce the askarel content of effluent streams. These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

V. SCRAP DISPOSAL PROCEDURES

The manufacture and use of capacitors [illegible] processes which produce askarel-saturated [illegible] and liquids containing or composed entirely of askarel, which should be disposed of as [illegible]. Specific sources of these materials appear throughout this document but may be placed [illegible] categories:

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1. Capacitor units impregnated with askarel, production and field rejects.

2. Manufacturing process liquid wastes containing askarel.

3. Solid waste purposely or accidently saturated with askarel.

Disposal should be done in a manner which consistent with proper concern for the environment and which minimizes any release of askarels to the environment.

A. Disposal of Capacitor Units

Scrap capacitor units can be generated during manufacturing processes or during field service.

Production rejects are those capacitors which are rejected after the impregnation process in the course of production by the capacitor manufacturer. They may be rejected for mechanical or electrical reasons, or because of obsolescence.

Field rejects are those units which are rejected or which, for other reasons, are to be scrapped after shipment from the plant where they were manufactured.

1. Production Rejects—Rejected capacitors in capacitor manufacturing plants represent a concentration of askarel. It is important that their disposition be made in a manner consistent with proper concern for the environment. Therefore, capacitors should be disposed of only in supervised dry landfill sites which meet all applicable State requirements.

Care should be exercised in insure that no loss of liquid will occur during transportation to the disposal site.

Incineration of scrap capacitors in facilities designed to accept such solids should provide an alternative means of disposal as such services become available in the future.

2. Field Rejects—Small capacitors (defined as containing less than 2 pounds of askarel) are practically always used as components in other electrical or electromechanical equipment. Typical examples of large quantity usage of such capacitors are in fluorescent lamp ballasts and residential air conditioning equipment. Failure of such capacitors may result in scrapping of the device of which it is a part (as in a fluorescent ballast) or replacement and scrapping of the individual capacitor (as in a room air conditioner). However, the majority of such capacitors do not fail in service, but are scrapped as a result of wearing out or obsolescence of the devices in which the capacitors are used as components. Thus, the matter of disposal is characterized by a low concentration of small quantities of askarel throughout the country and, indeed, throughout the world. Fortunately, the nature of the devices and equipment in which such capacitors are used is such that they are normally disposed of in dry landfills as a matter of convenience. Since it is impractical at present to exercise any meaningful control over the disposition of the bulk of such devices and equipment, it is imperative that askarel used for impregnating small capacitors be limited to the recently introduced type which contains a typical concentration of 0.4 percent of the higher coiling homologs. *

Large capacitors (those incorporating more than 2 pounds of askarel) should be disposed of according to the procedure for production rejects (see par. A.1).

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* Monsanto Method T-02302.

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3. Disposal of Liquid Wastes

All waste askarel or liquid wastes containing askarel should be disposed of in accordance with one of the following procedures:

1. Incineration—Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability and, finally, suitable scrubbers to remove the HCl which will be formed; e.g., (1) 2-second dwell time at 2000°F and 3 percent excess oxygen in stack gas; (2) 1 1/2-second dwell time at 2700°F and 2 percent excess oxygen in stack gas.

   These facilities should meet the applicable requirements of the State in which they are located and should control effluents within the limits set forth in this document.

2. Toxic and Hazardous Waste Disposal Sites—Certain landfill sites have been classified by State and Federal Governments as suitable for the disposal of toxic and hazardous liquids. Where such approved sites exist, they may be used for the disposal of liquid wastes described in this document. (See Section 4.)

3. Packaging and Shipment—

   a. Transportation to the disposal facility should be in containers which will prevent leakage and accidental loss of askarel to the environment.

   b. Containers should be labeled as to contents and precautions relative to loss to the environment.

   c. Containers used for this purpose should not be used for any other materials or retired from service until they are completely cleaned. Any solvents used in cleaning these containers will be contaminated with askarel and should be disposed of according to the same procedures herein described.

C. Disposal of Solid Wastes
(See Par. A for Scrap Capacitors)

All solid wastes which have been saturated with askarel should be disposed of by the following procedure:

1. The saturated wastes should be placed into leak-proof containers and transported to a supervised dry landfill site meeting State requirements. Alternatively, they can be disposed of by incineration in State-approved facilities.

2. Solid absorbents used for spills can be disposed of uncontained in the supervised dry landfill site; transport to the site should be in closed containers. Alternatively, incineration can be used in accordance with par. B (See Section 4 for facilities).

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VI. LABELING

Capacitor units vary greatly in size and in end use or application. Small capacitor units are frequently applied as a component of another piece of equipment such as a fluorescent lighting ballast, a roadway or area lighting luminaire, a motor, etc. In such applications a label on the capacitor unit referencing approved disposal procedure would not normally be visible when the piece of equipment is disposed of.

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For the foregoing reasons the method of providing disposal instructions for small capacitors and large capacitors is treated separately.

1. Small Units (Incorporating Less Than 2 Pounds of Askarel)—Small capacitors are defined as those which contain askarel in quantities up to about two (2) pounds each and in which the free liquid does not exceed 0.4 pound. They are hermetically sealed in metallic cases. Such capacitors are applied as a component of a larger piece of equipment. Attaching a label to such equipment referencing this Guideline or describing disposal procedures would be of limited practical value.

2. Large Capacitor Units (Incorporating More Than 2 Pounds of Askarel)—The capacitor manufacturer should affix a label in a conspicuous place, referencing this document or describing disposal procedures consistent with it. This label should contain, as a minimum, the following information:

CAUTION:

THIS CAPACITOR CONTAINS A POLYCHLORINATED BIPHENYL (PCB). TO AVOID POSSIBLE ENVIRONMENTAL CONTAMINATION, IT SHOULD BE DISPOSED OF ONLY IN SUPERVISED DRY LANDFILL AREAS MEETING STATE REQUIREMENTS OR IN INCINERATION FACILITIES DESIGNED FOR DISPOSAL OF PCB'S.

SEE AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINES C107.1- ( ) FOR FURTHER INFORMATION. (WHEN APPROVED. COPIES WILL BE AVAILABLE FROM ANSI, 1430 BROADWAY, NEW YORK, NEW YORK 10018.)

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MINUTES C-107 CAPACITOR SUBCOMMITTEE

The capacitor subcommittee of ANSI C-107 convened at 4:00 P.M. 1/12/76, Statler O'Hare (North) Hotel. Richard Rollins acted as Chairman, R. D. McClain as Secretary. (Attendance roster attached.)

Mr. Clifford Tuttle presented a draft of the E.I.A. Spill Notification Plan for PCB's. There was general concurrence this should be considered on Tuesday for incorporation in C-107. (Copy attached)

Section II.B (Agenda): Complexity of toxicity data appeared to be too great for inclusion in the standard. An article from the CIGRE publication, Electra, was distributed for consideration, "The Properties of Askarels and Recommendations for Their Use in Electrical Equipment." (Copy attached)

Section II.C. (Agenda) Liquid for disposal appears to be greater for transformers than for capacitors. Disposal by incineration can be accomplished by Monsanto, Rollins, or Chemtrol. (Note: Monsanto limits moisture content; Rollins and Chemtrol do not). Although disposal of liquid contained in drums is satisfactory for some controlled landfill sites, disposal by incineration was considered preferrable. Addition of sentence to part 3.5.2 of standard, "Preference should be given to incineration."

Section II.C.2 (Agenda): EPA indication that landfill is only presently suitable method for disposal of saturated solids was noted. Likewise, differences in control of landfill sites, state to state, was noted. No change in standard recommended.

Section II.C.3: It was noted that "nuclear" hazardous waste landfill sites must be on state or federal land.

Section II.D.1 (Agenda): Disposal of capacitor units, intact, as opposed to opening and draining fluid and resealing before disposal was discussed. The small amount of fluid to be drained, the integrity of insert units, and the necessity for complex control over drainage procedures indicated disposal of intact units to be preferrable.

(Subcommittee adjourned until 8:00 A.M., 1/13/76).

Section II.E. (Agenda): Members were requested to obtain and submit data on labelling of apparatus, cartons, etc. containing P.C.B. beyond that already contained in the standard, as practiced by their companies, and submit at the next meeting. Further discussion tabled.

Section II.D.2 (Agenda): (Reference - Standard C-107, part 3.5.1.2, page 12): Mr. Tuttle agreed to prepare a draft recommending removal of capacitors from equipment before disposal. (The alternative of disposal of the entire equipment in accordance with PCB procedures will be considered.)

Section II.F (Agenda): (Reference - Standard C-107, Appendix B, Page 20, "General"). Mr. Rollins will review pertinence of reference A.S.T.M. document, as well as E.P.A procedures to

be referenced by Mr. Otte. Mr. Rollins will request list of additional laboratories doing analytical work (from Monsanto). Mr. Stenger agreed to prepare a statement on precautions to be followed in obtaining PCB samples.

Section II.G. (Agenda): The subcommittee concurred that addition to standard dealing with disposal procedures is desirable. Mr. Willy proposed the following changes:

Add to contents page:

"7. Disposal of Laboratory Samples."

Add to the body of the text:

"7. Disposal of Laboratory Samples. The disposal of laboratory samples and materials used by laboratories for testing and experimental purposes that may contain various amounts of polychlorinated biphenyls must be carefully controlled as outlined in paragraphs 3.3 thru 3.3.6 and 3.5 thru 3.5.3."

Section II.H. (Agenda): Disposal of PCB containing water effluents into municipal sewage systems (from washing of clothing, hands, etc,): Differences in requirements by various regulatory agencies was noted. (Requirements of standard C-107 part 3.3.6 for control of discharges into drains was noted.) Mr. Tuttle will prepare a draft revision, recognizing the reduced hazard of Aroclor 1016 discharges.

Section II.I. (Agenda): (Loss of PCB vapors) It was noted that PCB or PCB containing materials should not be incinerated except under rigidly controlled conditions. Mr. Rollins will prepare a draft for possible addition to Standard C-107 after part 3.4 on loss of vapors, recognizing absence of technologically established methods of detection and measurement.

Section II.J. (Agenda): (Reference was made to the preceding section on discharges into sanitary waste disposal system, and to part 3.3.6 of standard C-107). Mr. Ritner will prepare a draft for consideration of possible addition to part 3.3.6 of standard C-107. Compatibility with statement on discharges into streams or sewers is desired.

Date of the next meeting was tentatively set for Tuesday, February 28.

Respectfully Submitted,

Robert D. McClain
Acting Secretary

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QUALITY ORIGINAL

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Binghamton, NY 13902

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Memo / Steam / heat / Self-serv "PB Task Force"

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W Building, Room 1458
235-3494
December 7, 1976

PCB TASK FORCE

GREENTREE - Mr. J. Morris
SHARON - Mr. H. Sheppard
SHARON - Mr. R. Schwab
BLOOMINGTON - Mr. D. Sauter
W BUILDING - Mr. R. Wills
W BUILDING - Mr. J. Daley

cc: W Building - Mr. E. Clarke
W Building - Mr. D. Keiser
W Building - Mr. S. Pitts
South Boston - Mr. J. Aldworth

The following highlights the minutes of the PCB Task Force meeting of December 2, 1976. All members of the Task Force were present with R. Cartmell representing Joe Morris.

Commercial

- The notification procedure, NEMA task force status, and to-date customer reaction were reviewed.

- Sharon, South Boston, Bloomington, and T&D Marketing will review EPA's PCB Economic Analysis for the purposes of comment and criticism. R. Wills will draft the common response.

- On December 14, the NEMA Task Force will meet. John Aldworth will be the Westinghouse representative.

Legal

- Roger Wills reviewed the current federal and state legal situation regarding the regulation of PCB's.

- EPA is expected to begin regulation hearings on PCB's on or about December 20, 1976.

- Roger identified the following as legal contacts in PCB matters:

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Power Systems Contract Questions	John Irby and Sam Pitts
Industry Products Contract Questions	Spence Nunley and Harlin Rosensweig
Toxicity Questions	Roger Wills

- The development of strategies with regard to EPA and impending regulations will be deferred until after the December 14 NEMA meeting and the Ducember 20 EPA meeting.

- No recommendations with regard to personnel who had worked with PCB's were identified.

Quality Control

- Harry Sheppard will develop a recommendation with regard to a testing procedure for incoming oil shipments for all divisions.

- Dick Schwab will develop a policy recommendation for operational control and monitoring of PCB's for all divisons. Also, the recommendation will be made for each division to appoint a PCB coordinator from operations.

Technical

- Harry Sheppard reviewed the current R&D work being done to develop a quick identification method for finding PCB's in oil. He will continue to follow.

- Outlined the test capability and commercial price for Sharon testing

  a. 5PPM or more test in oil - 100/day on two shift basis @ $100 per test.

  b. 100PPB in oil - two day test @ $1,200 per test.

  c. 1PPB in water - 10/day @ $200 per test.

- On the subject of insureability, Factory Mutual will publish shortly those requirements that a liquid must meet in order for Factory Mut to recommend insureability of the liquid at the askarel rate. It i



expected that the current silicon fluid will meet these requirements.

- We are currently working with oil suppliers to develop a less expensive fluid that will meet these Factory Mutual requirements. Harry Sheppard is managing this effort.

- A preliminary funded research project to EPRI to identify the scope of the mixing problem and the development of a method to remove PCB's from oil was tabled until we know more clearly what NEMA will be willing to take action in this area.

Repair and Service

- R. Cartmell reviewed the repair policy ARD is in the process of developing, as well as identifying those plants which will continue to repair askarel filled equipment. (See Attached)

- Joe Morris will call an initial meeting to include C. Witherington, D. P. Keiser, and R. Halverson to review the commercial aspects of a Westinghouse repair policy. An additional meeting with the Transformer Divisions operations' PCB representatives may also be convened.

No date was set for the next meeting of the PCB Task Force. Additional meetings as required will be called by the chairman.

John Sullivan

Attachment



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From Engineering Department
WIN
Date September 30, 1975
Subject PCB Spill Control

BLOOMINGTON WORKS

To Messrs. J. B. Brittain
D. Williams

cc: R. Sawyer
cc: A. Fink

Attached is a copy of the suggested emergency response to notice of a PCB spill, which will be the subject for discussion at 10:30 A.M., Wednesday, October 1, 1975 in the North Engineering Conference Room.

It is intended that this response and attached materials be used as a guide for anyone notified that D.A.D. polychlorinated biphenyl (Inerteen or Aroclor) has been involved in a spill. The actions outlined have not been reviewed by Roger Wills, nor have they been derived from any similar program at Sharon or at Monsanto. We suggest Mr. Will's comments be obtained at an early date.

Prevention of a spill is not a part of the proposed response.

Consideration of means for funding necessary action in event of a spill is requested.

Although distribution of these instructions should be limited, it appears desirable that more than the three member committee should have the benefit of part, or all, of the information attached.

Designation of a spokesman to the press is also requested.

Robert D. McClain, Chairman

jg

Attachment

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Suggested Response to Notice of PCB Spill:

Scope: Establish fast response to notice of major spill of PCB (Aroclor/Inerteen); outline action to notify authorities; indicate methods of containment; establish standard, basic information for use by those concerned; act to minimize costs, liability, loss of material.

A. Incoming notice of spill to be directed to

1) R. D. McClain - (812) 332-4421, Extension 273
or (812) 332-5056 (Home)

2) R. B. Sawyer - (812) 332-4421, Extension 220
or (812) 332-7461 (Home)

3) A. J. Fink - (812) 332-4421, Extension 298
or (812) 332-5775, (Home)

B. Notice of spill will be provided by telephone (by one of the above 3 persons) to the following:

1) Monsanto (618) 271-5835
and Bill Moore, Akron

2) Indiana Stream Pollution Control Board
(317) 633-4420
or (317) 633-5369
or (317) 633-4360 (after hours)

Immediately, whenever possible, notify the nearest downstream water user.

3) E.P.A.

Coast Guard?

a) If spill is North of U.S. Highway #40,
Chicago (312) 353-6188
or (312) 353-5638

b) If spill is South of U.S.Highway #40,
Evansville (812) 423-6871, Extension 265
[same for Illinois]

4) Illinois

5) Westinghouse

a) Gateway - Roger Wills, Attorney: WIN 8-235-5815
L.D.
Home

Alternate:

(3)

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(b) Bloomington - D.A.D.
- D. M. Sauter, Plant Manager - 332-0095
- D. Williams, Manager of Manufacturing -339-0611
- J. Brittain, Manager of Engineering - 332-5622
- J. L. Shoaff, Matls & Stds. Engineer - 876-5207
- G. E. Mercier, Capacitor Engrg. Manager - 336-3880
- N. E. Maguire, Manager of Shipping - 332-7646
- K. Kelly, Purchasing Manager - 332-9666

C. All rail shipments, Sauget, Illinois to Bloomington, are via Illinois Central Railway, over routes indicated on attached map. ("A")

Nearest highway point (town) is circled on attached segment of highway map. ("B" or "C")

Bloomington D.A.D. representative will depart for spill site as soon as possible.

It is understood that the railway will be in charge of wreck salvage. (A booklet from the American Railway Association outlines handling of non-hazardous materials.) Depending on the magnitude of the wreck, one of the following will be in charge:

Large - Superintendent
Medium - Assistant Superintendent
Small - Local Trainmaster ("D")

Assistance to be rendered will be in the nature of providing information as to identification of the material, precautions to be followed, the urgent need to control and contain the spill, and possible means for disposal.

a) Nature of material: See label on car. (Copy attached) ("E") See attached extract from ANSI C-107. See industrial hygiene excerpts from C-107. ("F")

b) CAUTION: DO NOT FLUSH SPILL WITH WATER.

DO NOT INCINERATE OR BURN IN THE OPEN ATMOSPHERE.

EXTINGUISH ANY FLAMES WITH DRY TYPE FIRE EXTINGUISHERS.

c) Contain spills onto open ground with earth dikes or with absorbent material such as OIL DRY, SAND,SAWDUST, etcl, or soil, which can be recollected for future disposal.

Drain off fluid remaining in tank car into sealed drums.

d) Note that fluid is heavier than water and is almost completely insoluble.

Spills into shallow, still water, or slow moving water, may be

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contained with suitable dikes allowing surface clear water to overflow if necessary. Pump or sluice out contaminating fluid from bottom.

e) PCB fluids and contaminated materials may be disposed by placing in sealed drums. Shipment, to disposal site (Monsanto or Chemtrol), will be arranged subsequently.

Visitation to the site by Indiana Stream Control Board Representative should be expected (in Indiana), to review action being taken, and possibly to make suggestions or to offer instructions. (If instructions are not followed, Westinghouse may become liable for the consequences.) ("G")

D. Information to the press: Inquiries from the press or other news media are to be referred to _____.

E. Indiana State Board of Health regulation SPC-16 requires 5 steps to be completed on notice of spill (See excerpt from Indiana Environmental Health Action, attached). Submission of a complete report may be required by the Indiana Stream Pollution Control Board Technical Secretary.

F. Notice of lesser spills may require part, or all, of the actions above:

Possible "medium" spills can result during shipment of waste to Chemtrol for disposal. Such spills can involve other authorities (than Illinois or Indiana).

A card of minimum instructions (similar to that of Monsanto's on the tank car) is to be provided to the driver on each shipment. (See attached). ("H")

G. Spills from apparatus enroute to a customer are likely, but smallest in potential magnitude.

"Spill Control Instructions" attached.

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SPILL CONTROL INSTRUCTIONS

FOR CAPACITORS BEING SHIPPED

1) Put information on bill of lading and each shipment with instructions to the shippers and to the recipient.

2) If the spill is while the product is in transit, notification will be received by D.A.D. Shipping. Shipping notify McClain, Fink, or Sawyer.

3) If it is a limited incident in transit (a few units) Shipping will give the following instructions:

   a) Return product to Bloomington or the nearest Apparatus Repair Shop with proper protection.

   b) How to clean truck, dock, etc. and dispose of waste material.

4) When the product is returned to Bloomington, an RMR number will be requested and then the normal RMR procedure will apply. If it is delivered to an ARP then a Service Order must be entered by the District Office for the repair. Bloomington must insure that the ARP has instructions for proper handling and disposal.

5) If it is a major incident (truck wreck or many units) notification will again be to D.A.D. Shipping.

6) If the description of the severity warrants it, a D.A.D. representat will be sent to the site immediately.

7) D.A.D. will give information immediately to the shipper on how to contain spills, clean up afterwards and then dispose of waste material.

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8) The product should be protected against further spillage and returned to Bloomington or sent to an ARP for repair. Either the RMR procedure or Service Order will apply as appropriate.

9) If the product has been delivered and is on the customer's site, notification will most likely be through the appropriate District Office (either Sales or Service). Care must be taken to insure that the customer recognizes that the clean-up and disposal are his problems. We can offer advice and give recommended techniques.

10) Repair will be accomplished through the carrier claim route with the site chosen after a survey of the problems. It may be any one of the following:

A. Repaired on customer's site.

B. Sent to ARP.

C. Returned to Bloomington.

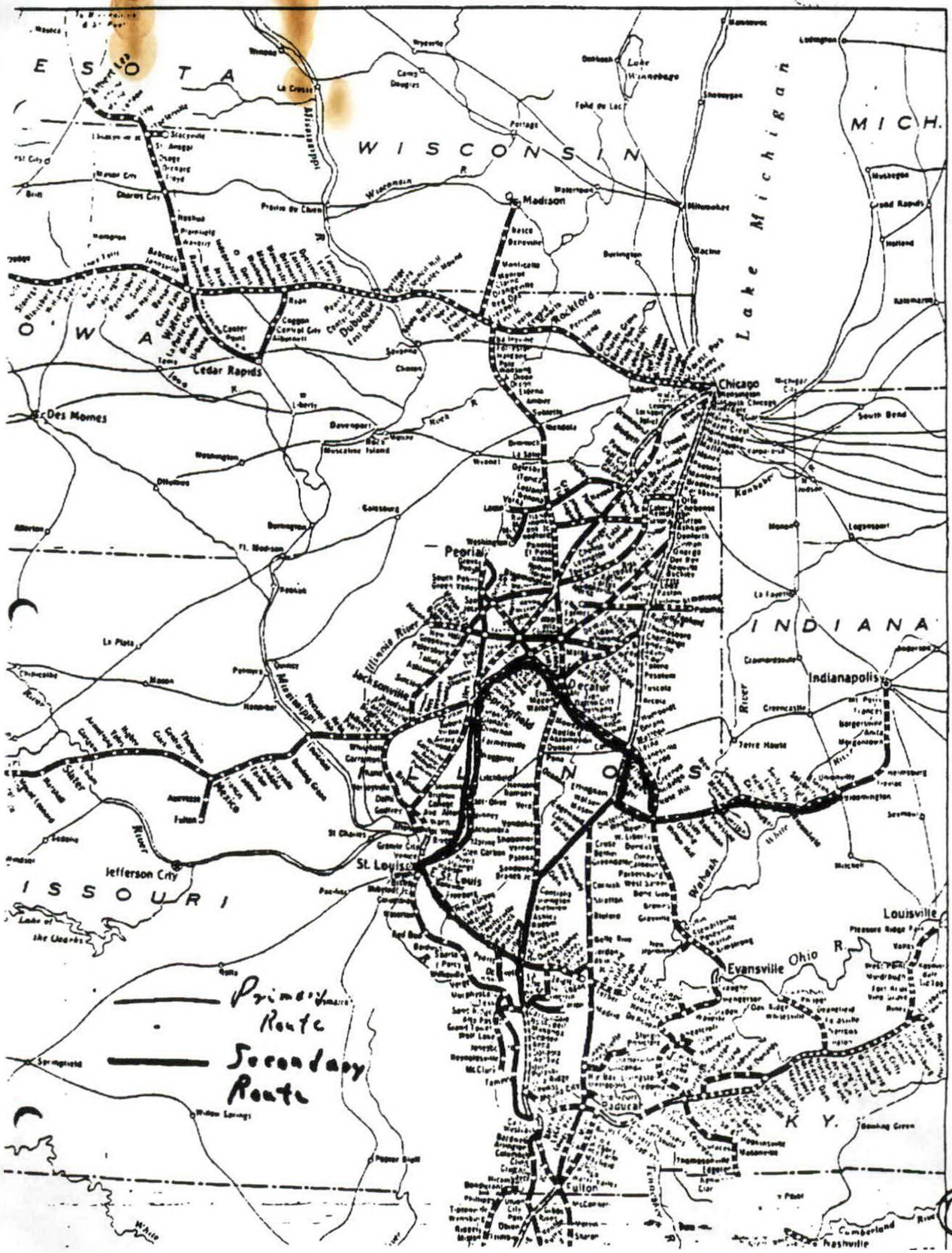
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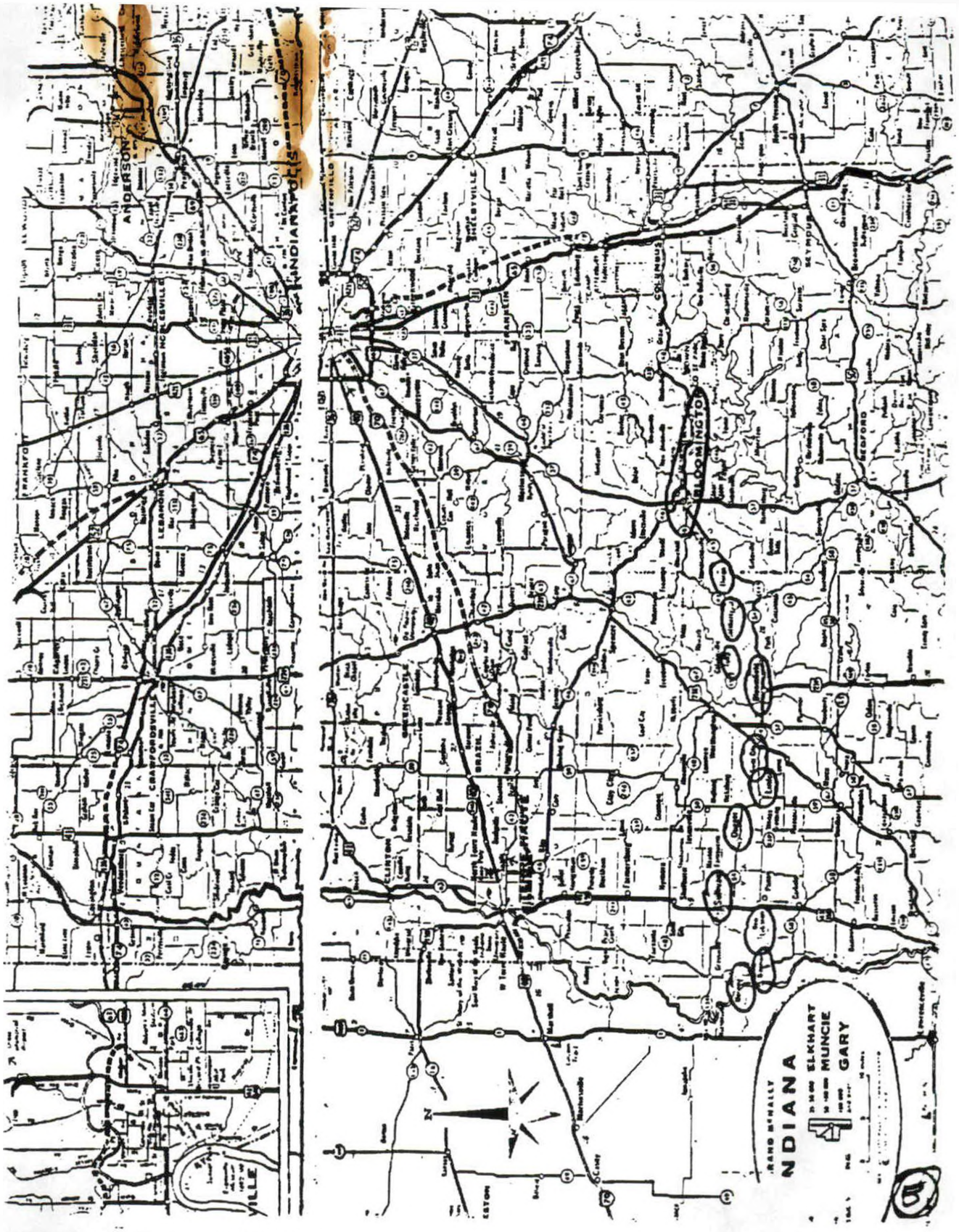
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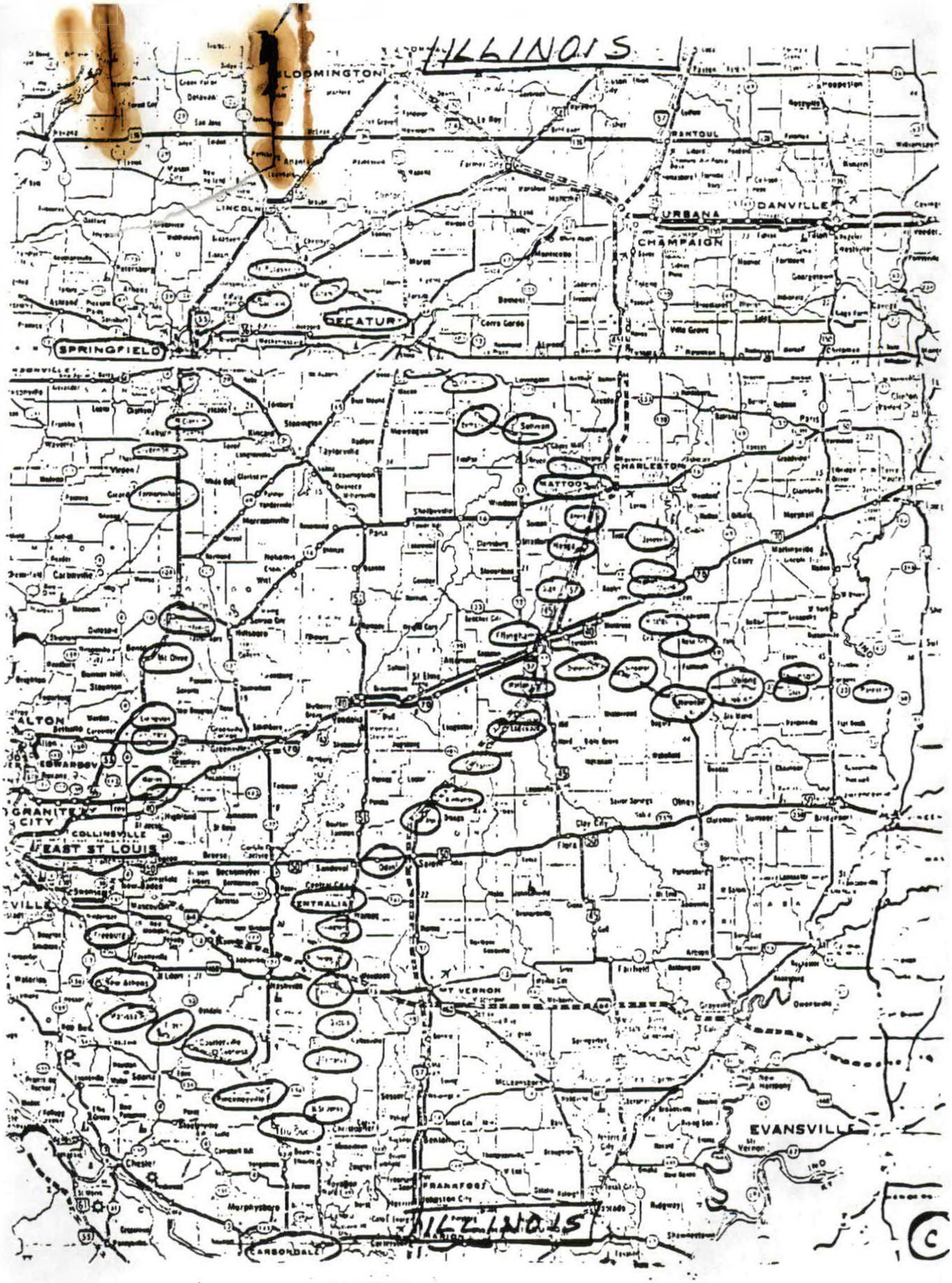


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PAMPHLET NO. 34

Recommended Methods

For

The Safe Loading and Unloading

Of

Tank Cars Used for Transporting Non-Dangerous Commodities

And

Protection of Equipment

REVISED NOVEMBER 1963

ISSUED BY

ASSOCIATION OF AMERICAN RAILROADS

Operations and Maintenance Department

FREIGHT LOADING & CONTAINER SECTION

59 East Van Buren Street

CHICAGO, ILL. 60605

763900

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PAMPHLET No. 31

PREFIX

The methods outlined herein for the selection of tank cars as well as the procedure for loading and unloading such cars are applicable only to tank cars used for the transportation of commodities not classed as dangerous by the Regulations of the Interstate Commerce Commission.

For methods to be followed in the selection, loading and unloading of tank cars for the transportation of commodities classed as dangerous by the currently effective Interstate Commerce Commission Regulations see T. C. George's Freight Tariff No. 15, supplements, re-issues, etc – or Bureau of Explosives' Pamphlet No. 21.

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QUALIFICATIONS OF TANK CARS

A tank car that leaks, or that has any defect which would make leakage during transit probable, or that has not been properly tested and marked, must not be used.

Before a tank car may be used for the transportation of any commodity other than that commodity for which it is currently equipped and authorized as indicated by the name of the commodity stenciled on the tank in accordance with the marking requirements of the specification, the owner of the car, or party authorized by the owner, must secure approval for changes in the stenciled name, manhole closure, safety valve, induction and eduction valves and pipes, and such other changes as are necessary to make the car suitable for the new service. A certificate showing the changes which were approved and made and the date must be filed with the Secretary, Mechanical Division, Association of American Railroads.

LOADING OF TANK CARS

Before tank cars are loaded, the shipper must examine the tanks and their appurtenances to see that the safety and outlet valves, the safety vents, the closures of all openings, and the protective covers of all appurtenances are in proper condition. Tanks with bottom discharge outlets must have their outlet caps off or outlet cap plugs open during entire time tanks are being loaded. After loading, tanks which show any dropping of liquid contents at the seams or rivets, or with bottom outlet valves which permit more than a dropping of the liquid with the outlet caps off or outlet cap plugs open, must not be offered for transportation until proper repairs have been made.

Tank cars equipped with interior heater coils must be loaded with heater coil inlet and outlet caps off during entire time tanks are being loaded and show no leakage with these caps off.

All closures of openings in tank cars and of their protective housings must be properly secured in place by the use of a bar, wrench, or other suitable tool. A wrench having a handle at least 18 inches long must be used to apply the outlet valve cap. Manhole covers and outlet valve caps must be made tight against leakage of vapor and liquid, by use of gaskets of suitable material, before cars are tendered to carrier for transportation. Luting materials must not be used in outlet cap or on threads of bottom outlet.

Combustible liquids, with flashpoint between 81 and 200 degrees Fahrenheit, must not be loaded into tank cars on carriers' property from tank trucks, wagons or other portable containers.

Section 8 of Rule 35, Uniform Freight Classification No. 7, effective August 1, 1964, provides in part as follows: ". . . Flammable liquids with flash point of 80 degrees Fahrenheit or below, in tank cars, and . . . Combustible liquids having a flash point lower than 200 degrees Fahrenheit, except asphalt or tar, in tank cars, must not be shipped and will not be delivered unless consigned to parties accepting delivery on private sidings, or consigned to parties accept-



ing delivery from railroad sidings where facilities exist for piping liquid from tank cars to permanent storage tanks."

Maximum weight of load must not exceed Load Limit stenciled on car.

After loading is completed car must be examined to ascertain if there is sufficient clearance between side bearings to permit free curvature of trucks. The average clearance per side bearing should not exceed ¼ inch.

UNLOADING OF TANK CARS

In unloading tank cars the following rules must be observed:

Section 8 of Rule 35, Uniform Freight Classification No. 7, effective August 1, 1964, provides in part as follows: ". . . Flammable liquids with flash point of 80 degrees Fahrenheit or below, in tank cars, and . . . Combustible liquids having a flash point lower than 200 degrees Fahrenheit, except asphalt or tar, in tank cars, must not be shipped and will not be delivered unless consigned to parties accepting delivery on private sidings, or consigned to parties accepting delivery from railroad siding where facilities exist for piping liquid from tank cars to permanent storage tanks."

Unloading operations should be performed only by reliable persons properly instructed and made responsible for careful compliance with these regulations.

Brakes must be set and wheels blocked on all cars being unloaded.

Caution signs must be so placed on the track or car as to give necessary warning to persons approaching car from open end or ends of siding and must be left up until after car is unloaded and disconnected from discharge connection. Signs must be of metal, at least 12 by 15 inches in size and bear the words, "STOP—Tank Car Connected," or "STOP—Men at Work," the word "STOP" being in letters at least 4 inches high and the other words in letters at least 2 inches high. The letters must be white on a blue background.

Before manhole cover or outlet valve cap is removed, tank car must be relieved of all interior pressure by cooling tank with water or venting tank by raising safety valve or opening vent on dome at short intervals. These precautions are not necessary when car is equipped with a manhole cover which hinges inward or with an inner manhole cover which does not have to be removed to unload the car, and when pressure is relieved by piping vapor into a condenser or storage tank.

After pressure, if any, is released, seal should be broken and manhole cover removed as follows:

Screw type. Cover must be loosened by placing bar between manhole cover lug and knob. After two complete turns, so that vent openings are exposed, the operation must be stopped, and if there is any sound of escaping vapor, the cover must be again screwed down tightly and interior pressure relieved as prescribed above, before again attempting to remove the cover.

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Hinged and bolted type.—All nuts must be unscrewed one complete turn, after which same precautions as prescribed for screw type cover must be observed.

Interior type.—All dirt and cinders must be carefully removed from around cover before yoke is unscrewed.

When car is unloaded through bottom outlet valve, manhole cover must be adjusted as follows:

Screw type.—Manhole cover must be put in place, but not entirely screwed down, in order that air may enter tank through vent holes in threaded flange of cover.

Hinged and bolted type.—A small wooden block should be placed under one edge of cover.

Interior type.—Screw must be tightened up in yoke so that cover will be brought up within one half inch of closed position.

When unloading through bottom outlet of cars equipped with interior manhole type of covers, and in all cases where unloading is done through the manhole (unless special covers are used, provided with safety-vent opening and tight connection for discharge outlet), the manhole must be protected against entrance of dust, dirt, cinders or other foreign matter, that might cause contamination of the lading, by asbestos or metal covers or by being covered and surrounded with wet burlap. Burlap must be kept damp by replacement or the application of water as needed.

Seals or other substances must not be thrown into the tank. Also care must be taken to avoid spilling any of the contents over car or tank.

Valve rod handle or control in dome must be operated a few times to see that outlet valve in bottom of tank is on its seat before valve cap is removed.

Valve cap, or reducer when large outlet is to be used, must be removed with suitable wrench after set screws are loosened and a pail is placed in position to catch any liquid that may be in outlet chamber. If valve cap or reducer does not unscrew easily, it must be tapped lightly with mallet or wooden block in an upward direction. If leakage shows upon starting the removal, cap or reducer must not be entirely unscrewed, but sufficient threads must be left engaged and sufficient time allowed to permit escape of any accumulation of liquid in the outlet chamber. If leakage stops or initial rate of leakage diminishes materially, cap or reducer may be entirely removed. If initial rate of leakage continues, further efforts must be made to seat the outlet valve. If this fails, the cap or reducer must be screwed up tight and tank must be unloaded through the dome.

If upon removal of the outlet cap the outlet chamber is found to be blocked with frozen liquid or any other matter, replace cap immediately and make careful examination to determine that outlet casting has not been cracked. If the obstruction is not frozen liquid, the car must be unloaded through the dome. If the obstruction is frozen liquid and no crack has been found in the outlet casting, the car may, if circumstances require it, be unloaded from the bottom as follows:

Remove cap and attach unloading connections immediately. Then, before opening the valve inside the tank car, apply steam to outside of outlet casting or wrap casting with burlap or other rags and apply hot water to melt the frozen liquid. In any event, top unloading is considered safer than bottom unloading.

Unloading connections must be securely attached to unloading pipes on dome or to bottom discharge outlets before discharge valves are opened.

Tank cars must not be allowed to stand with unloading connections attached after unloading is completed, and throughout the entire period of unloading, or while car is connected to unloading device, the car must be attended by the unloader.

If necessary to discontinue unloading a tank car for any reason, all unloading connections must be disconnected. All valves must first be tightly closed, and the closures of all other openings securely applied.

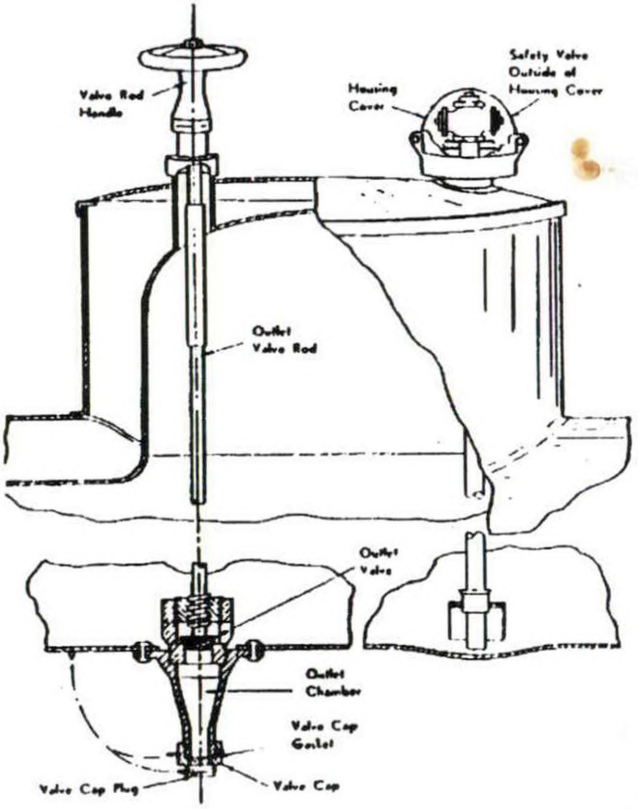
As soon as a tank car is completely unloaded, all valves must be made tight, the unloading connections must be removed and all other closures made tight, except that heater coil inlet and outlet pipes must be left open for drainage. The manhole cover must be applied by the use of a bar or wrench, the outlet valve reducer and outlet valve cap by the use of a wrench having a handle at least 48 inches long, and the outlet valve cap plug, end plug, and all other closures of openings and of their protective housings by the use of a suitable tool.

Railroad defect cards must not be removed.

Ground around connections must be covered with fresh, dry sand or dirt, if any materials have been spilled previously.

All tools and implements used in connection with unloading should be kept clean at all times.

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Valve Rod Handle
Housing Cover
Safety Valve Outside of Housing Cover
Outlet Valve Rod
Outlet Valve
Outlet Chamber
Valve Cap Gasket
Valve Cap Plug
Valve Cap

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ANSI C-107

OFFICIAL STANDARDS PROPOSAL

THIS OFFICIAL STANDARDS PROPOSAL IS AN OFFICIAL DRAFT OF A PROPOSED STANDARD DEVELOPED WITHIN NEMA, OR IN COOPERATION WITH OTHER INTERESTED ORGANIZATIONS, FOR CONSIDERATION BY ORGANIZATIONS OUTSIDE OF NEMA

SECTION 1
PREFACE

I. GENERAL

Askarels consisting of or containing polychlorinated biphenyls (PCB's) have been used in many applications for over forty years, but only recently was evidence discovered that PCB's are widely dispersed in the environment. Systematic investigations of the biological effects of PCB's have been undertaken within the past few years to establish the effects of specific formulations upon specific species. Some studies have shown that PCB's may be an environmental contaminant. Simultaneously, significant steps have been taken by U. S. industry to limit further releases of PCB's to the environment.

PCB's have been used in three broad types of applications for the past forty years, as follows: (a) "open ended" applications, for example, in paints, specialty inks, paper coatings, plastics, etc., (b) "nominally closed" applications, for example, as the working fluid in hydraulic or heat transfer systems; and (c) "closed electrical system" applications, specifically as the insulating fluid in certain types of transformers and capacitors. The Monsanto Company is the sole U. S. producer of PCB's. It has discontinued supplying the material for all type (a) and (b) applications.

Evaluations of the alternatives and risk/benefits involved in the continued use of PCB's in closed electrical systems are summarized in the following.

II. BENEFITS

Askarel-filled transformers do not burn or sustain fire under conditions of internal electrical arcing.

Askarel-filled power and industrial capacitors are significantly smaller, more reliable, more durable, and safer than oil-filled capacitors. As a result, askarels have supplanted mineral oils in more than 90 percent of the power and industrial capacitors made today. Over the past few decades most of the equipment that incorporates such capacitors has been designed to take particular advantage of the size, safety and reliability benefits of askarel capacitors (e.g., many types are today less than 14 percent of the size of equivalent oil capacitors and have a life expectancy of ten to more than twenty years).

Various federal, state and local codes, therefore, require their continued use in or adjacent to public, commercial and industrial buildings which locations present the greatest potential danger to life and property.

III. RISKS

In the United States, medical records over a nearly forty-year period show that the only adverse health effects experienced by U.S. workers exposed to askarels, either during the manufacture of these liquids or of electrical equipment containing these liquids, have been limited to occasional cases of non-chronic chloracne or other temporary skin lesions or irritations.

Askarel-filled transformers and capacitors are delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environ-

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ment, transformer failures are limited to approximately 0.02 percent of the units in service per year. With respect to capacitors, such losses are limited to approximately 0.02 percent of the askarel put into service per year. In addition, limited amounts of PCB's can get into the environment during the manufacture, delivery, improper use, maintenance, repair and disposal of transformers and capacitors.

Specific control measures have been instituted by individual manufacturers and are supplemented and strengthened by national standards and procedures such as this Guide which provides information to prevent the inadvertent loss of PCB's to the environment at all stages from initial askarel manufacture through ultimate disposal.

IV. ALTERNATIVES

For technical and local and national code reasons, it would be impossible to replace most askarel-filled transformers now in service with oil-filled units of equivalent ratings, without major construction changes that would be required to compensate for the fire resistance of the askarel-filled units. For certain applications and locations, dry-type transformers may replace askarel-filled transformers.

For new installations, while many of the limitations noted above would still apply, building and installation design provisions could be made to accommodate the use of oil-filled, open dry-type, or sealed dry-type transformers provided necessary technical, code, physical size, and cost considerations are properly evaluated.

The principal alternative to askarels for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1932 level and would necessitate the redesign and replacement of such widely used equipment as fluorescent light fixtures and racks for power and induction heating capacitors, which could not now accommodate the increased size of oil capacitors while maintaining their present ratings.

The cost of askarel liquids is about five to ten times more than mineral oil. Thus, long before there were any environmental concerns about PCB's, there was a strong economic incentive to find other less expensive insulating liquids with the desirable characteristics of askarels. Since the 1930's at least ten major chemical or electrical companies have invested large amounts of time and money in this search, all with no success. While potential substitutes that are most costly than askarels have also received some consideration (e.g., fluorinated liquids), little is known about either their electrical performance or possible ill effects upon the environment. There are today no fluids that can be used as a direct replacement for askarels.

V. INTERDEPARTMENTAL TASK FORCE ON PCB'S

An in-depth study of PCB's has recently been completed by five Executive Branch Departments of the federal government. This Interdepartmental Task Force on PCB's issued their report entitled, "Polychlorinated Biphenyls and the Environment," in May, 1972. * See Section 1 Page 3 for the conclusion quoted from page 4 of this report.

* Distributed by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Price $6.00.

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Table 1
Typical Properties of Arochlor 1016

Property and Method	Typical Values
Color (APHA)	40, max.
Condition	Clear
Specific Gravity at 25/15.5°C (ASTM D 1810)	1.362-1.372
Acidity (mg. KOH/g.) (ASTM D 974, D 664)	0.010 max.
Moisture	35 ppm, max.
Refractive Index at 25°C (ASTM D 1817)	1.6215-1.6235
Inorganic (Free) Chlorides (ASTM D 1821)	0.05 ppm. max.
Pour Point (ASTM D 97)	-14°C or lower
Dielectric Constant (ASTM D 924) (1000 Hz at 100°C)	4.70-4.90
Resistivity (ASTM D 1169) (500 VDC at 100°C, 0.1-inch Gap.)	500 x 10^9 ohm-cm, min.
Hydrolysis Stability Test (ASTM D 1820) (As Chlorides)	0.5 ppm, max.
Thermal Stability Test (ASTM D 1936) (As Chlorides)	0.4 ppm, max.
Distillation Range (ASTM D 20 Corrected)	
10 percent Distilled by Weight	323°C, min.
90 percent Distilled by Weight	356°C, max.
Higher Boiling Homologs (Monsanto Method T-02302)	0.4 percent, max.
Sulfates (ASTM D 117)	None
Dielectric Strength at 25°C (ASTM D 877)	35 kV, min.
Flash Point, Cleveland Open Cup (ASTM D 92)	338°F, min.
Fire Point	None to Boiling Point
Corrosion Test (6 hours at 210°C with bright aluminum foil)	
Change in Weight of Aluminum	0.0 percent
Viscosity at 100°F (SUS) (ASTM D 88)	71-81
Specific Heat at 25°C	0.30
Coefficient of Expansion (ASTM D 1903)	0.00069 cc/cc/°C
Fixed Chlorine (Carius)	41.3 ± 0.5 percent
Power Factor at 100°C 60 Hz (Monsanto Method T-2273)	
Bulk	1 percent, max.
Drums	4 percent, max.

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SECTION 2
CAPACITOR GUIDELINES

I. INTRODUCTION

The environmental effects of askarels are under in-depth study by governmental and other agencies. Askarels have been considered relatively harmless to humans based on about forty years of safe industrial usage. There has been no known instance of human injury when they were used under the normally accepted precautions and conditions of handling in both manufacturing and user applications.

Traces of askarels are being found in the environment and in fish and birdlife. The long-term genetic and ecological effects are not yet completely understood. For these reasons, care should be taken to contain askarels and minimize their entry into the environment.

There are two general classes of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their high degree of nonflammability, they are used in transformers where personnel safety is of paramount importance.

Capacitor-grade askarel has a lower degree of chlorination (composed primarily of the 3-chlorine isomers of biphenyl) and a higher degree of biodegradability. Generally, it has not been found in animal life. It is used in capacitors where the extreme degree of nonflammability required in transformers is of less importance.

Although capacitor- and transformer-grade askarels both contain members of the PCB family, they do differ in composition, degree of biodegradability, persistence in nature, electrical stability, chemical stability, and degree of nonflammability (both are recognized as nonflammable). It is for these reasons that this section of the Guidelines is intended to apply to capacitor-grade askarel.

II. CAPACITOR-GRADE ASKAREL

In September of 1971, a new grade of capacitor impregnant, Aroclor 1016, was made available to the industry. This new grade contains a typical concentration of 0.4 percent by weight of the higher boiling homologs of the chlorinated biphenyls. * Aroclor 1016 replaces Aroclor 1242 which previously was the major capacitor impregnant and contained around 7 percent of the higher boiling homologs (the more persistent in nature). This 0.4 percent level of the higher boiling homologs should be the maximum concentration acceptable in any capacitor impregnant. Aroclor 1242 and 1254, previously used as impregnants, do not meet this requirement and should no longer be used in capacitors designed and manufactured for alternating-current applications.

Aroclor 1016 has the same UL nonflammability rating as Aroclor 1242. Its typical properties are given in Table 1. (See Section 2 Page 2.)

III. PLANT HOUSEKEEPING AND EMPLOYEE SAFETY

The following procedures and limits are intended to be minimum requirements to be met by manufacturers and users of capacitors containing askarel. Handling, control and disposal procedures are given, together with exposure limits and indicated antidotes and cleanup procedures.

A. Material

Askarel for use in capacitors should consist of homologs and isomers of chlorinated biphenyl with the concentration of the higher boiling homologs at about 0.4 percent. * Aroclor 1016 is considered to be the standard impregnant meeting these requirements.

* Monsanto Method T-02302.

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Commonly used solvents include benzene, kerosene, acetone, trichloroethane, trichloroethylene and perchloroethylene. Typical vapor pressure data for Aroclor 1016 are:

0°C	=	0.001 mm
25°C	=	0.006 mm
150°C	=	4.3 mm
200°C	=	29.0 mm

At 25°C and 760 mm Hg pressure, saturated air contains approximately 0.09 mg/liter.

[1 mg/liter = 90.0 ppm (v/v)]

[1 ppm (v/v) = 0.011 mg/liter]

B. Bulk Fluid Shipment, Receiving, and Transfer

Shipment of askarel from point of manufacture to point of receiving should be done in closed containers such as rail tank cars, truck tanks, marine or barge tanks, or sealed drums. Containers should be labeled as to contents and carry a label cautioning against loss of fluid to the open environment. Containers used to transport askarel should not be used for storage or to transport other material without being completely cleaned of all traces of askarel. (Cleaning procedures must take cognizance of precautions against excessive exposure and of the need for proper disposal of contaminated cleansing solvents and materials as set forth in Part V of this Section.) Transfer from shipping containers to processing systems should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluid lost by leakage or spills from the transfer system and from the storage containers.

Drums to be retired from use should be cleaned before crushing, delivery to scrap dealers, or other disposal. Contaminated cleaning fluids and materials should be disposed of as indicated in Part V.

C. General Safety Precautions

Although it is generally accepted that exposure to capacitor-grade askarel is not hazardous provided simple precautions are taken, exposure should still be avoided.

1. Vapors—The odor of askarel is noticeable well below the maximum air concentrations considered safe. Up to 1.0 milligram per cubic meter of air has been determined to be the maximum safe level of exposure during an 8-hour work day (Par. G, reference 8). The procedures for performing the necessary analytics are contained in Section 5, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls."

Breathing vapor or fumes from heated askarel should be avoided. Provisions should be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure to askarel (especially at 55°C or higher). The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride, and small percentages of carbon dioxide, carbon monoxide and oxygen. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarel is necessary under emergency conditions, an approved gas mask or self-contained breathing apparatus should be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of an accident. If the odor of askarel is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

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2. Liquid—Unlike insulating oil, there is virtually no fire hazard in handling askarel. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should be such as to minimize or eliminate contact with askarels. Use of eye protection is recommended. The use of porous gloves which can absorb and retain askarels is to be avoided. Barrier creams* or resistant gloves† should be used if contact is unavoidable. Use of enclosed transfer and handling equipment, processing equipment, and mechanical washers reduces direct contact.

Medicinal washes or mild detergents followed by the application of cold cream will reduce the irritation resulting from the contact of an open cut or abrasion with askarel.

Safety glasses with side shields or a face shield should be worn when handling askarels. If liquid askarel contacts the eyes, the eyes should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician. (A drop of castor oil has been found to reduce irritation.)

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under the supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or using toilet facilities.

D. Manufacturing Housekeeping

Manufacturing equipment and operating procedures should safeguard against loss of askarels to the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 50°C. Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all askarel processing areas to ensure against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

Spills of askarel should be removed promptly by means of absorptive material, such as sawdust, or trapped and removed by pumping or other suitable means.

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* For example, PLY No. 9 Gel (Milburn Co., Detroit, Michigan), or Kerodex 471 (Ayers Laboratories P. O. Box 8230, Church Street Station, New York, N. Y. 10049), or the equivalent.

† Edmont, Solvit [illegible] (Mersick of Bridgeport, 2[illegible] Cross Street, Bridgeport, Conn. 06601), or the equivalent.

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Waste fluids containing askarel not suitable for reconditioning or reuse should be collected (by means of traps, drip pans, trays, etc.) from the various parts of the manufacturing and processing area (including washers or other cleaning devices). Disposal should be made in accordance with Part V of this section.

Wiper rags, clothing and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled laundering or disposal (see Part V of this section).

D. Disposal of Askarel Wastes

Methods for disposal of liquids and saturated solids generated by the manufacturing operation should be in accordance with those outlined in Part V of this section and should include (but not be limited to) the following wastes:

1. Contaminated liquid askarel which is unsuitable for reclaiming as a dielectric fluid.
2. Liquid askarel from solvent operations or water/detergent type washers.
3. Saturated earth or other absorbent media from filtering operations.
4. Saturated sawdust or other absorptive materials from spills.
5. Saturated filters from vapor control devices and other filters.
6. Saturated wastes (paper, rags, etc.).
7. Saturated, spent gasket materials.
8. Askarel-contaminated vacuum pump oils.
9. Askarel-contaminated steam jet vacuum system condensates.

E. Miscellaneous Procedures

1. Spills by leakage from finished capacitors should be cleaned up promptly by means of absorbent media which should then be moved to containers provided for that purpose within the containment area and later disposed of properly.
2. Askarel wastes should never be disposed of down effluent drains or sewers. The utmost care must be exercised to prevent accidental loss by these avenues to the environment.
3. Capacitors failing tests or otherwise designated for disposal must be controlled and handled in accordance with the intent of the procedures above, finally being disposed of by one of the means outlined in Part V of this section.

G. References

1. Monsanto Industrial Chemicals Company: Technical Bulletin O-FF/1R, Aroclor® Polychlorinated Polyphenyls (Biphenyls) (November 1971).
2. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. AMA Archieves of Environmental Health 9:545 (1964).
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7. Greenburg, L., M.R. Mayers, and A.R. Smith: The Systemic Effects Resulting from Exposure to Certain Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology 21:29 (1939).

8. Hygienic Guide Series "Chlorodiphenyls" (January-February 1965) by the American Industrial Hygiene Association, 210 Haddon Avenue, Westmont, N.J. 08108.

IV. CONTROL OF WATER EFFLUENTS

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems in capacitor manufacturing plants are probably contaminated as a result of past practices, and askarel traces may continue to show up in effluent streams for some time. However, the level should continue to decrease with the proper containment of askarel wastes and no further discharges into drain systems. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams and that accidental spills be prevented from getting into such streams.

A. Concentration Limits

The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.

B. Monitoring Streams

On a regular basis consistent with plant situations, all effluent streams should be analyzed. The procedures for performing the necessary analyses are contained in Section 5, Analysis of Water and Sediment for Polychlorinated Biphenyls. This procedure or its equivalent should be used.

C. Methods for Minimizing Effluent Stream Contamination

The ideal approach is to totally isolate all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant. Carbon adsorption, limestone beds, and solvent extraction are techniques which can be applied to reduce the askarel content of effluent streams. These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

V. SCRAP DISPOSAL PROCEDURES

The manufacture and use of capacitors involve processes which produce askarel-saturated solids and liquids containing or composed entirely of askarel, which should be disposed of as wastes. Specific sources of these materials appear throughout this document but may be placed into three categories:

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1. Capacitor units impregnated with askarel, production and field rejects.

2. Manufacturing process liquid wastes containing askarel.

3. Solid waste purposely or accidently saturated with askarel.

Disposal should be done in a manner which is consistent with proper concern for the environment and which minimizes any release of askarels to the environment.

A. Disposal of Capacitor Units

Scrap capacitor units can be generated during manufacturing processes or during field service.

Production rejects are those capacitors which are rejected after the impregnation process in the course of production by the capacitor manufacturer. They may be rejected for mechanical or electrical reasons, or because of obsolescence.

Field rejects are those units which are rejected or which, for other reasons, are to be scrapped after shipment from the plant where they were manufactured.

1. Production Rejects—Rejected capacitors in capacitor manufacturing plants represent a concentration of askarel. It is important that their disposition be made in a manner consistent with proper concern for the environment. Therefore, capacitors should be disposed of only in supervised dry landfill sites which meet all applicable State requirements.

   Care should be exercised to insure that no loss of liquid will occur during transportation to the disposal site.

   Incineration of scrap capacitors in facilities designed to accept such solids should provide an alternative means of disposal as such services become available in the future.

2. Field Rejects—Small capacitors (defined as containing less than 2 pounds of askarel) are practically always used as components in other electrical or electromechanical equipment. Typical examples of large quantity usage of such capacitors are in fluorescent lamp ballasts and residential air conditioning equipment. Failure of such capacitors may result in scrapping of the device of which it is a part (as in a fluorescent ballast) or replacement and scrapping of the individual capacitor (as in a room air conditioner). However, the majority of such capacitors do not fail in service, but are scrapped as a result of wearing out or obsolescence of the devices in which the capacitors are used as components. Thus, the matter of disposal is characterized by a low concentration of small quantities of askarel throughout the country and, indeed, throughout the world. Fortunately, the nature of the devices and equipment in which such capacitors are used is such that they are normally disposed of in dry landfills as a matter of convenience. Since it is impractical at present to exercise any meaningful control over the disposition of the bulk of such devices and equipment, it is imperative that askarel used for impregnating small capacitors be limited to the recently introduced type which contains a typical concentration of 0.4 percent of the higher coiling homologs. *

   Large capacitors (those incorporating more than 2 pounds of askarel) should be disposed of according to the procedure for production rejects (see par. A.1).

* Monsanto Method T-02302.

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B. Disposal of Liquid Wastes

All waste askarel or liquid wastes containing askarel should be disposed of in accordance with one of the following procedures:

1. Incineration—Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability and, finally, suitable scrubbers to remove the HCl which will be formed; e.g., (1) 2-second dwell time at 2000°F and 3 percent excess oxygen in stack gas; (2) 1 1/2-second dwell time at 2700°F and 2 percent excess oxygen in stack gas.

   These facilities should meet the applicable requirements of the State in which they are located and should control effluents within the limits set forth in this document.

2. Toxic and Hazardous Waste Disposal Sites—Certain landfill sites have been classified by State and Federal Governments as suitable for the disposal of toxic and hazardous liquids. Where such approved sites exist, they may be used for the disposal of liquid wastes described in this document. (See Section 4.)

3. Packaging and Shipment—

   a. Transportation to the disposal facility should be in containers which will prevent leakage and accidental loss of askarel to the environment.

   b. Containers should be labeled as to contents and precautions relative to loss to the environment.

   c. Containers used for this purpose should not be used for any other materials or retired from service until they are completely cleaned. Any solvents used in cleaning these containers will be contaminated with askarel and should be disposed of according to the same procedures herein described.

C. Disposal of Solid Wastes
(See Par. A for Scrap Capacitors)

All solid wastes which have been saturated with askarel should be disposed of by the following procedure:

1. The saturated wastes should be placed into leak-proof containers and transported to a supervised dry landfill site meeting State requirements. Alternatively, they can be disposed of by incineration in State-approved facilities.

2. Solid absorbents used for spills can be disposed of uncontained in the supervised dry landfill site; transport to the site should be in closed containers. Alternatively, incineration can be used in accordance with par. B (See Section 4 for facilities).

VI. LABELING

Capacitor units vary greatly in size and in end use or application. Small capacitor units are frequently applied as a component of another piece of equipment such as a fluorescent lighting ballast, a roadway or area lighting luminaire, a motor, etc. In such applications a label on the capacitor unit referencing approved disposal procedure would not normally be visible when the piece of equipment is disposed of.

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For the foregoing reasons the method of providing disposal instructions for small capacitors and large capacitors is treated separately.

1. Small Units (Incorporating Less Than 2 Pounds of Askarel)— Small capacitors are defined as those which contain askarel in quantities up to about two (2) pounds each and in which the free liquid does not exceed 0.4 pound. They are hermetically sealed in metallic cases. Such capacitors are applied as a component of a larger piece of equipment. Attaching a label to such equipment referencing this Guideline or describing disposal procedures would be of limited practical value.

2. Large Capacitor Units (Incorporating More Than 2 Pounds of Askarel)— The capacitor manufacturer should affix a label in a conspicuous place, referencing this document or describing disposal procedures consistent with it. This label should contain, as a minimum, the following information:

CAUTION

THIS CAPACITOR CONTAINS A POLYCHLORINATED BIPHENYL (PCB). TO AVOID POSSIBLE ENVIRONMENTAL CONTAMINATION, IT SHOULD BE DISPOSED OF ONLY IN SUPERVISED DRY LANDFILL AREAS MEETING STATE REQUIREMENTS OR IN INCINERATION FACILITIES DESIGNED FOR DISPOSAL OF PCB'S.

SEE AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINES C107.1- ( ) FOR FURTHER INFORMATION. (WHEN APPROVED, COPIES WILL BE AVAILABLE FROM ANSI, 1430 BROADWAY, NEW YORK, NEW YORK 10018.)

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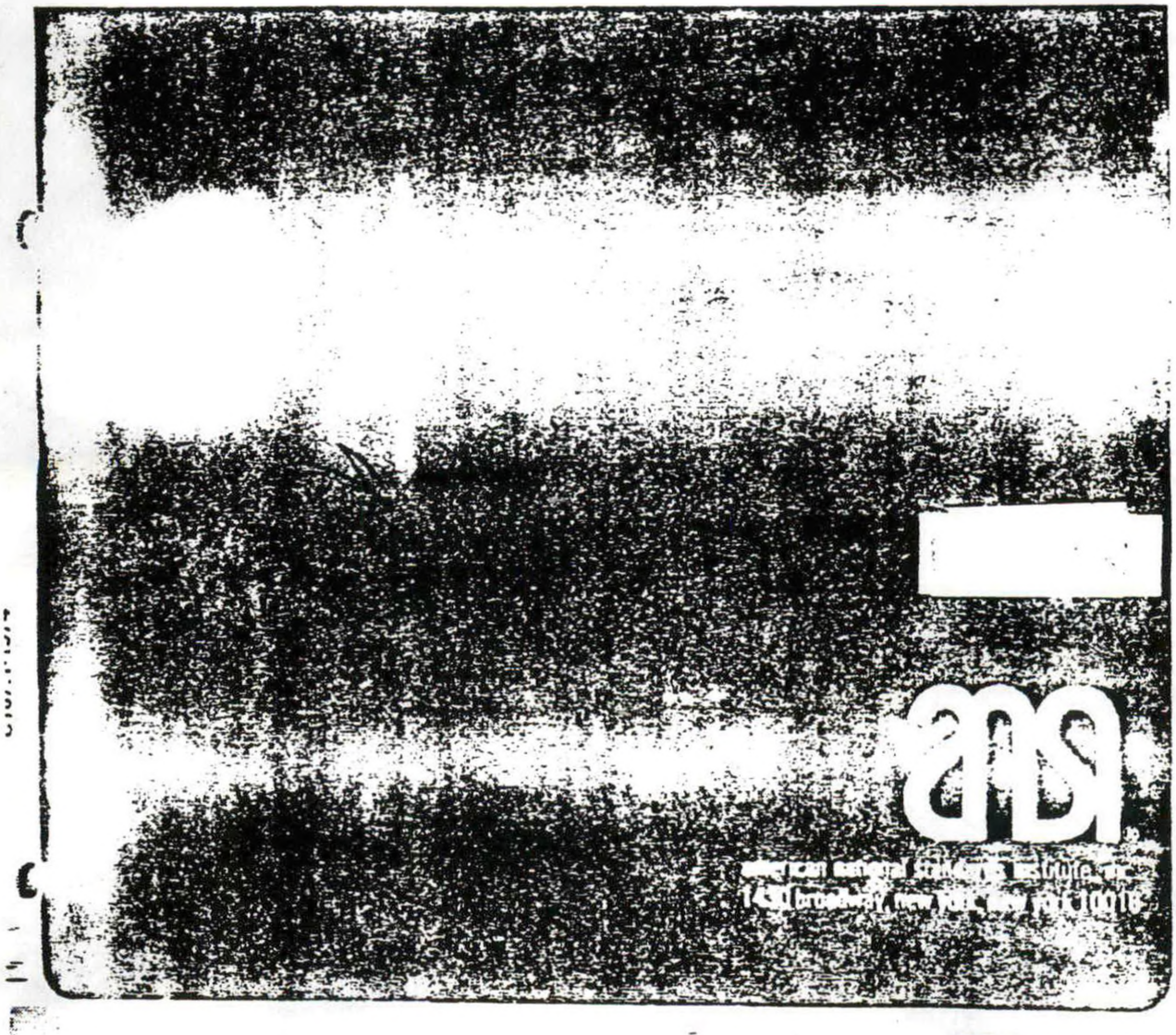
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ANSI C107.1-1974

American National Standard

guidelines for handling and disposal of capacitor- and transformer-grade askarels containing polychlorinated biphenyls



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ANSI
C107.1-1974

American National Standard Guidelines for Handling and Disposal of Capacitor- and Transformer-Grade Askarels Containing Polychlorinated Biphenyls

Secretariat

National Electrical Manufacturers Association

Approved January 9, 1974

American National Standards Institute, Inc

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American National Standard

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Foreword

(This Foreword is not a part of American National Standard Guidelines for Handling and Disposal of Capacitor- and Transformer-Grade Askarels Containing Polychlorinated Biphenyls. C107.1-1974.)

Recognizing that the polychlorinated biphenyls present in askarels were being identified as environmental pollutants and the urgent need for procedures and guides for their safe use and disposal, the Board of Directors of the Power Equipment Division of the National Electrical Manufacturers Association (NEMA) in June 1970 appointed a committee to review the general problem and propose recommendations. In September 1970, the NEMA board approved, as recommended by the committee, the sponsorship of an American National Standards Committee for the use and disposal of askarels in electrical equipment.

American National Standards Committee C107 was established in April 1971. NEMA was designated as the secretariat. An organizational meeting was held on September 14, 1971. Mr W. B. Papageorge, Monsanto Company, was appointed chairman. Committee members included representatives of capacitor and transformer manufacturers, utilities, governmental departments and agencies, and maintenance and disposal service companies. A steering committee and two subcommittees – one to develop guidelines for the capacitor industry, the other for the transformer industry – were established.

The scope and primary objective of the committee was designated as the development of procedures and guides for the safe use, maintenance, and disposal of askarel and askarel-soaked materials used in electrical equipment.

Additional objectives proposed were as follows:

(1) To serve as a source for technical information and advice for federal, state, and local authorities and for the information of all others concerned.

(2) To encourage the development of suitable disposal facilities and maintain a list of their capabilities and locations, for the information of all concerned.

(3) To serve as the advisory group for U.S. participation in the International Commission on Rules for the Approval of Electrical Equipment (CEE), the International Electrotechnical Commission (IEC), the Pan American Standards Commission (COPANT), the International Conference on Large High Tension Electric Systems (CIGRE), and other international organizations.

The final draft of the guidelines was completed in late November 1972. NEMA issued the guidelines as an Official Standards Proposal in January 1973. It was submitted to the American National Standards Institute for approval as an American National Standard and was approved by the Standards Institute on January 8, 1974.

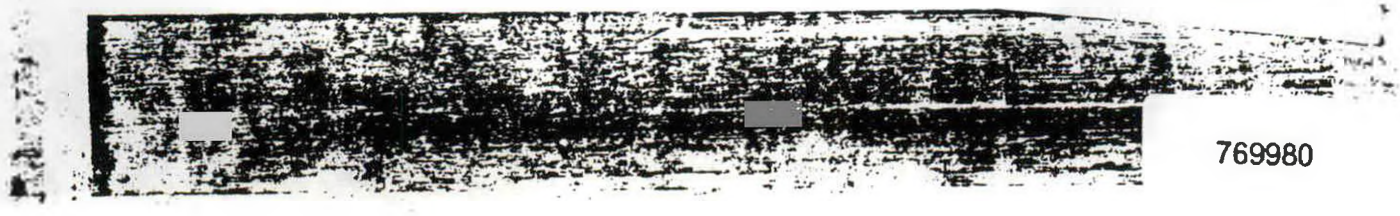
Suggestions for improvement of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Use and Disposal of Askarel and Askarel-Soaked Materials in Electrical Equipment, C107. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C107 Committee had the following members.

W. P. Papageorge, Chairman
A. M. Salazar, Secretary

Organization Represented	*Name of Representative*
Certified Askarel Manufacturers Association	N. R. Clark A. Peterson
Chem-Tron Pollution Services, Inc.	Louis E. Wagner
Doble Engineering Company	A. L. Rickley
Electrical Utilities Company	A. O. Hauser E. M. Moore (Alt)
Electric Light and Power Group	F. R. Lengefeld H. A. Orrisht J. J. Cawley (Alt)

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Organization Represented	*Name of Representative*
Electronic Industries Association	Arnold S. Doty
Environmental Protection Agency	Kenneth J. Hood
General Services Administration	Charles C. Travis
Gilbert Associates Inc	R. J. Schatz
Institute of Electrical and Electronics Engineers, Inc	E. L. Rabb
Monsanto Company	W. P. Papageorge
	P. G. Bennignus (Alt)
National Bureau of Standards	Stanley P. Wasik
National Electrical Manufacturers Association	K. C. Chang
	W. S. Grogan
	R. D. McClain
	H. R. Rowe
	Ken McGee (Alt)
Rollins-Purle, Inc	H. A. Aisenstat
Tennessee Valley Authority	William R. Nicholas
U.S. Department of Agriculture, Rural Electrification Administration	John Leuttig, Jr
U.S. Department of the Army	D. M. Crabtree

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American National Standard Guidelines for Handling and Disposal of Capacitor- and Transformer-Grade Askarels Containing Polychlorinated Biphenyls

1. Scope

This standard establishes guidelines for the safe use, maintenance, and disposal of askarel and askarel-soaked material used in capacitors and transformers.

2. General Information

2.1 **General.** The term "askarel" generally describes a broad class of nonflammable synthetic chlorinated hydrocarbon insulating liquids [illegible] used in capacitors, transformers, [illegible] equipment operated at power frequencies.

Askarels consisting of [illegible] chlorinated biphenyls (PCBs) have been used in many applications for more than 40 years, but only recently was evidence discovered that PCBs are widely dispersed in the environment. System and laboratory studies of the biological effects of PCBs have been undertaken within the past few years to establish the effects of specific formulations upon specific species. Some studies have shown that PCBs may be an environmental contaminant. Simultaneously, significant steps have been taken by U.S. industry to limit further releases of PCBs to the environment.

PCBs have been used in three broad types of applications for the past 40 years, as follows:

(1) "Open-ended" applications, for example, in paints, specialty inks, paper coatings, plastics, etc.

(2) "Nominally closed" applications, for example, as the working fluid in hydraulic or heat-transfer systems.

(3) "Closed electrical system" applications, specifically as the insulating fluids in certain types of transformers and capacitors.

[1] The Monsanto Company is the sole U.S. producer of PCBs. It has discontinued supplying the material for all applications given in 2.1(1) and 2.1(2).

Evaluations of the benefits, risks, and alternatives involved in the continued use of PCBs in closed electrical systems are summarized in 2.2 through 2.4.

2.2 **Benefits.** Askarel-filled transformers do not burn or sustain fire under conditions of internal electrical arcing.

Askarel-filled power and industrial capacitors are significantly smaller, more reliable, more durable, and safer than oil-filled capacitors. As a result, askarels have supplanted mineral oils in more than 90% of the power and industrial capacitors made today. Over the past few decades most of the equipment that incorporates such capacitors has been designed to take particular advantage of the size, safety, and reliability benefits of [illegible] (for example, many types are less than 1/5 of the size of equivalent oil capacitors) and have a life expectancy of 10 to more than 20 years.

Various federal, state, and local codes, therefore, require their continued use in or adjacent to public, commercial, and industrial buildings, which for [illegible] present the greatest potential danger to life and property.

2.3 **Risks.** In the United States, medical records over a nearly 40-year period show that the only adverse health effects experienced by U.S. workers exposed to askarels, either during the manufacture of these liquids or of electrical equipment containing these liquids, have been limited to occasional cases of nonchronic chloracne or other temporary skin lesions or irritations.

Askarel-filled transformers and capacitors are delivered to customers as sealed units from which there is no escape of askarel under normal operation. Although certain types of equipment failures can permit loss of some askarel to the environment, transformer failures are limited to approximately 0.02% of the units in service per year. With respect to capacitors, such losses are limited to approximately 0.02% of the askarel put into service per year. In addition, limited amounts of PCBs can get into the environment during the manufacture, delivery, improper use, maintenance, repair, and disposal of transformers and capacitors.

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Specific control measures have been instituted by individual manufacturers and are supplemented and strengthened by national standards and procedures such as this standard, which provides information to prevent the inadvertent loss of PCBs to the environment at all stages from initial askarel manufacture through ultimate disposal.

2.4 **Alternatives.** For technical and local and national code reasons, it would be impossible to replace most askarel-filled transformers now in service with oil-filled units of equivalent ratings without major construction changes that would be required to compensate for the fire resistance of the askarel-filled units. For certain applications and locations, dry-type transformers may replace askarel-filled transformers.

For new installations, although many of the foregoing limitations would still apply, building and installation design provisions could be made to accommodate the use of oil-filled, open dry-type, or sealed dry-type transformers, provided that necessary technical, code, physical size, and cost considerations are properly evaluated.

The principal alternative to askarels for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1932 level and would necessitate the redesign and replacement of much widely used equipment, such as fluorescent light fixtures and racks for [illegible] the increased size of the capacitors while maintaining their present ratings.

The cost of askarels [illegible] about five to ten times more than mineral oil. Thus, long before there were any environmental concerns about PCBs, there was a strong economic incentive to find other, less expensive insulating liquids with the desirable characteristics of askarels. Since the 1930s at least ten major chemical or electrical companies have invested large amounts of time and money in this search, all with no success. Although potential substitutes that are more costly than askarels (such as fluorinated liquids) have also received some consideration, little is known about either their electrical performance or possible ill effects upon the environment. There are today no fluids that can be used as a direct replacement for askarels.

2.5 **Interdepartmental Task Force on PCBs.** An in-depth study of PCBs has recently been completed by five Executive Branch Departments of the federal government. This Interdepartmental Task Force on PCBs issued their report, entitled *Polychlorinated Biphenyls and the Environment*, in May 1972.[3] The following conclusion is quoted from page 4 of this report.

"The use of PCBs should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCBs in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCBs to all except manufacturers of electrical transformers and capacitors."

Reference should be made to the Interdepartmental Task Force Report for additional information and conclusions.

3. Capacitor Guidelines

3.1 **General.** The environmental effects of askarels are under in-depth study by governmental and other agencies. Askarels have been considered relatively harmless to humans based on about 40 years of safe industrial usage. There has been no known instance of human injury which were used under the normally accepted practices and conditions of handling in both the [illegible] and all-type [illegible].

Traces of askarels are being found in the environment and in fish and bird life. The long-term general ecological effects are not yet completely understood. For these reasons, care should be taken to contain askarels and minimize their entry into the environment.

There are two general classes of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their high degree of nonflammability, they are used in transformers where personnel safety is of paramount importance.

Capacitor-grade askarel has a lower degree of chlorination (composed primarily of the 3-chlorine isomers of biphenyl) and a higher degree of biodegradability. Generally, it has not been found in animal life. It is used in capacitors, where the extreme degree of nonflammability required in transformers is of less importance.

Although [illegible] and trivial [illegible] with [illegible] in composition, degree of biodegradability [illegible] in nature, electrical stability, chemical stability, and degree of nonflammability (both are recognized as nonflammable). It is for these reasons that Section 3 of this standard is intended to apply to capacitor-grade askarel

[3] Available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Va 22151.

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Table 1
Typical Properties of Aroclor 1016

Property	Test Method (See Note)	Typical Values
Color	APHA*	40, max
Condition	–	Clear
Specific Gravity at 25/15.5°C	ANSI C59.68-1965 (R1973) [2]	1.362–1.372
Acidity (mg KOH/g)	ANSI Z11.131-1964 (R1974) [3] ANSI Z11.59-1958 (R1971) [4]	0.010, max
Moisture	–	35 ppm, max
Refractive index at 25°C	ASTM D 1807-66 (1972) [5]	1.6215–1.6235
Inorganic (free) chlorides	ANSI C59.55-1963 (R1973) [6]	0.05 ppm, max
Pour point	ANSI Z11.5-1966 (R1972) [7]	−14°C or lower
Dielectric constant (1000 Hz at 100°C)	ANSI C59.22-1967 (R1973) [8]	4.70–4.90
Resistivity (500 V dc at 100°C, 0.1-inch gap)	ANSI C59.51-1965 (R1973) [9]	500 × 10⁸ Ω · cm, min
Hydrolysis stability test (as chlorides)	ANSI C59.106-1970 [10]	0.5 ppm, max
Thermal stability test (as chlorides)	ANSI C59.111-1970 [11]	0.4 ppm, max
Distillation range (corrected) 10% distilled by weight 90% distilled by weight	ANSI A37.9-1974 [12]	323°C, min 356°C, max
Higher-Boiling Homologues	ASTM D 3303-74 [1]	0.4%, max
Sulfates	ANSI C59.2-1974 [13]	None
Dielectric strength at 25°C	ANSI C59.19-1968 (R1973) [14]	35 kV, min
Flash point, Cleveland open cup	ANSI Z11.6-1973 [15]	338°F, min
Fire point	–	None to boiling point
Corrosion test (6 hours at 210°C with bright aluminum foil) (mg/cm² of weight change of aluminum	–	0.0%
Viscosity at 40°C, SUS	ANSI Z11.2-1958a (R1971) [16]	71–81
Specific heat at 25°C	–	0.30
Coefficient of thermal expansion	ANSI C59.53-1963a (R1973) [17]	0.0009 in/in/°C
Vapor pressure	–	<0.5 mm Hg
Relative humidity at 25°C equilibrium saturation	–	15, max 65, max

NOTE: Numbers in brackets refer to correspondingly numbered test methods in 5.1. References to the Text.

*American Public Health Association

†Saybolt Universal seconds

3.2 Capacitor-Grade Askarel. In September 1971 a new grade of capacitor impregnant, Aroclor 1016, was made available to the industry. This new grade contains a typical concentration of 0.4% by weight of the higher-boiling homologues of the chlorinated biphenyls. (See ASTM D 3303-74 [1].)[a] Aroclor 1016 replaces Aroclor 1242, which previously was the most commonly used impregnant [illegible] capacitors. [illegible] level of the higher-boiling homologues should be the maximum concentration acceptable in any capacitor impregnant. Aroclor 1242 and 1254, previously used as impregnants, do not meet this requirement and should no longer be used in capacitors designed and manufactured for alternating-current applications.

Aroclor 1016 has the same Underwriters' Laboratories flammability rating as Aroclor 1242. [illegible] typical properties are as given in Table 1.

3.3 Plant Housekeeping and Employee Safety. The procedures and limits given in 3.3 are intended to be minimum requirements to be met by manufacturers and users of capacitors containing askarel. Handling, control, and disposal procedures are given, together

[a] Numbers in brackets refer to corresponding numbers in 5.1, References to the Text.

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with exposure limits and indicated antidotes and clean-up procedures.

3.3.1 Material. Askarel for use in capacitors should consist of homologues and isomers of chlorinated biphenyl with the concentration of the higher-boiling homologues at about 0.4%. (See ASTM D 3303-74 [1].) Aroclor 1016 is considered to be the standard impregnant meeting these requirements.

Commonly used solvents include benzene, kerosene, acetone, trichloroethane, trichloroethylene, and perchloroethylene. Typical vapor pressure data for Aroclor 1016 are:

0°C = 0.001 mmHg
25°C = 0.006 mmHg
150°C = 4.3 mmHg
200°C = 29.0 mmHg

At 25°C and 760 mmHg pressure, saturated air contains approximately 0.09 mg/l.

NOTE:
1 mg/l = 90.0 ppm (v/v)
1 ppm (v/v) = 0.011 mg/l

3.3.2 Bulk Fluid Shipment, Receiving, and Transfer. Shipment of askarel from point of manufacture to point of receiving should be done in closed containers, such as rail tank cars, truck tanks, marine or barge tanks, or sealed drums. Containers should be labeled as to contents and carry a label cautioning against loss of fluid [illegible] environment. Containers used to transport [illegible] should not be used for storage and transport [illegible] all traces of askarel are removed. Cleaning of containers that have held askarel [illegible] exposure and disposal of contaminated cleaning [illegible] as set forth in 3.5.

Transfer [illegible] shipping containers to processing systems should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluid lost by leakage or spills from the transfer system and from the storage containers.

Drums to be retired from use should be cleaned before crushing, delivery to scrap dealers, or other disposal. Contaminated cleaning fluids and materials should be disposed of as indicated in 3.5.

3.3.3 General Safety Precautions. Although it is generally accepted that exposure to capacitor-grade askarel is not hazardous provided that simple precautions are taken, exposure should be avoided.

3.3.3.1 Vapor. The [illegible] safe. Up to 1.0 milligram per cubic meter of air has been determined to be the maximum safe level of exposure during an 8-hour workday. (See reference [19].) The procedure for performing the necessary analyses is contained in Section B3 of Appendix B. This procedure or its equivalent should be used.

Breathing vapor or fumes from heated askarel should be avoided. Provisions should be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure to askarel, especially at temperatures of 55°C or higher. The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride, and small percentages of carbon dioxide, carbon monoxide, and oxygen. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarel is necessary under emergency conditions, an approved gas mask or self-contained breathing apparatus should be worn. Such exposure should be under the surveillance of other personnel capable of effecting rescue in case of an accident. If the odor of askarel is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators, and replacement parts should have U.S. Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

3.3.3.2 Liquid. In contrast to the situation in which mineral insulating oils are handled, there is minimal need for the hazards in handling askarel. A limited [illegible] solvent action similar to that for [illegible] fats and oils of the skin with prolonged [illegible] tend to [illegible] drying of the skin. As a [illegible] latter [illegible] people are allergic to askarel and [illegible] exposure may result in skin [illegible] liquid and vapor are moderately irritating [illegible]

Operating procedures should be such as to minimize or eliminate contact with askarels. Use of eye protection is recommended. The use of porous gloves that can absorb and retain askarels is to be avoided. Barrier creams[4] or resistant gloves[5] should be used if contact is unavoidable. Use of enclosed transfer and handling equipment, processing equipment, and mechanical washers reduces direct contact.

Medicinal washes or mild detergents followed by the application of cold cream will reduce the irritation resulting from the contact of an open cut or abrasion with askarel.

Safety glasses [illegible] should be worn [illegible] handling askarels. If [illegible]

[4] For example, Pli-Y-No. 9 Gel (Milburn Company [illegible] Michigan) or Kerodex No. 71 (Ayerst Laboratories, New York, N.Y.) or the equivalent.

[5] For example, Dermont – Style 5-342 (Merrick of Bridgeport, Bridgeport, Conn.) or the equivalent.

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rel contacts the eyes, the eyes should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician. (A drop of castor oil has been found to reduce irritation.)

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under the supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking, or using toilet facilities.

3.3.4 **Manufacturing Housekeeping.** Manufacturing equipment and operating procedures should safeguard against loss of askarels to the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 65°C. Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all askarel processing areas to ensure against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

Spilled askarel should be [illegible]
means [illegible]
[illegible]
[illegible]

Waste floor [illegible]
[illegible]
[illegible] trays [illegible]
the manufacturing area [illegible]
washers or other cleaning devices. Disposal should be made in accordance with 3.5.

Wiper rags, clothing, and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled laundering or disposal (see 3.5).

3.3.5 **Disposal of Askarel Wastes.** Methods for disposal of liquids and saturated solids generated by the manufacturing operation should be in accordance with those outlined in 3.5, and should include, but not be limited to, the following wastes:

(1) Contaminated liquid askarel that is unsuitable for reclaiming as a dielectric fluid.

[illegible]
and [illegible]

(3) Saturated earth or [illegible]
filters or operations.

(4) Saturated sawdust or other absorptive materials from spills.

(5) Saturated filters from vapor-control devices and other filters.

(6) Saturated wastes (paper, rags, etc).

(7) Saturated, spent gasket materials.

(8) Askarel-contaminated vacuum pump oils.

(9) Askarel-contaminated steam jet vacuum system condensates.

3.3.6 **Miscellaneous Procedures.** Other safety considerations include the following:

(1) Spills by leakage from finished capacitors should be cleaned up promptly by means of absorbent media, which should then be moved to containers provided for that purpose within the containment area, and later disposed of properly.

(2) Askarel wastes should never be disposed of down effluent drains or sewers. The utmost care must be exercised to prevent accidental loss by these avenues to the environment.

(3) Capacitors failing tests or otherwise designated for disposal must be controlled and handled in accordance with the intent of the procedures given in 3.3.6(1) and 3.3.6(2), finally being disposed of by one of the means outlined in 3.5.

3.4 **Control of Water Effluents.** The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems in [illegible]
[illegible] as a result of past practices and askarel traces [illegible] continue to show up in effluent streams. It should be the objective that these should continue to decrease with the proper containment of askarel wastes [illegible] further this objective, this standard provides that no askarel wastes may be discharged in any water effluent streams and that accidental spills be prevented from getting into such streams.

3.4.1 **Concentration Limits.** The 1972 Environmental Protection Agency proposals are to keep PCB levels in rivers and lakes below 0.01 part per billion. This is currently under review by the EPA and standards are expected to be promulgated in 1974. Plant effluent streams should be managed and controlled in a manner anticipating these government standards.

3.4.2 **Monitoring Streams.** On a regular basis consistent with plant situations, all effluent streams should be analyzed. The procedure for performing the necessary analysis [illegible] in Section 3[illegible] of Appendix 3.

[illegible]
[illegible] Methods for Monitoring Effluent [illegible]
[illegible] termination. The basic approach is to secure [illegible] effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant. Carbon adsorption, limestone beds, and solvent extraction are tech-

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niques that can be applied to reduce the askarel content of effluent streams. These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

3.5 Scrap-Disposal Procedures. The manufacture and use of capacitors involve processes that produce askarel-saturated solids and liquids containing or composed entirely of askarel, which should be disposed of as wastes. Specific sources of these materials are described throughout this standard. They may be placed into three categories.

(1) Capacitor units impregnated with askarel, production and field rejects

(2) Manufacturing process liquid wastes containing askarel

(3) Solid waste purposely or accidently saturated with askarel

Disposal should be done in a manner that is consistent with proper concern for the environment and minimizes any release of askarels to the environment.

3.5.1 Disposal of Capacitor Units. Scrap capacitor units can be generated during manufacturing processes or during field service.

Production rejects are those capacitors that are rejected after the impregnation process in the course of production on the capacitor manufacturer. They may be rejected for mechanical [illegible] because of [illegible] electrical tests.

Field rejects are those units that are removed from service and should be scrapped. The equipment from the [illegible] contain askarel.

3.5.1.1 Production Rejects. Production capacitors at capacitor manufacturing plants typically contain a concentration of askarel. It is important that their disposition be made in a manner consistent with proper concern for the environment. Therefore, capacitors should be disposed of only in supervised dry landfill sites that meet all applicable state requirements.

Care should be exercised to ensure that no loss of liquid will occur during transportation to the disposal site.

Incineration of scrap capacitors in facilities designed to accept such solids should provide an alternative means of disposal as such services become available in the future.

3.5.1.2 Field Rejects. Small capacitors defined as containing less than 3 pounds of askarel are practicably [illegible] used as lighting ballasts in electronic electro-mechanical equipment. Typical examples of large quantity usage of such capacitors are in fluorescent lamp ballasts and residential air conditioning equipment. Failure of such capacitors may result in scrapping of the device of which it is a part (as in a fluorescent ballast) or replacement and scrapping of the individual capacitor (as in a room air conditioner). However, the majority of such capacitors do not fail in service but are scrapped as a result of wearing out or obsolescence of the devices in which the capacitors are used as components. Thus, the matter of disposal is characterized by a low concentration of small quantities of askarel throughout the country and, indeed, throughout the world. Fortunately, the nature of the devices and equipment in which such capacitors are used is such that they are normally disposed of in dry landfills as a matter of convenience. Since it is impractical at present to exercise any meaningful control over the disposition of the bulk of such devices and equipment, it is imperative that askarel used for impregnating small capacitors be limited to the recently introduced type, which contains a typical concentration of 0.4% or the higher-chlorinated homologues. (See ASTM D 3303-74 [1].)

Large capacitors (those incorporating more than 2 pounds of askarel) should be disposed of according to the procedure for production rejects (see 3.5.1.1).

3.5.2 Disposal of Liquid Wastes. All waste askarel or liquid wastes containing askarel should be disposed of in accordance with one of the procedures given in 3.5.2.1 through 3.5.2.3.

3.5.2.1 Incineration. Present knowledge indicates that proper incineration must involve [illegible] at a minimum dwell time and temperature in the incinerator plus oxygen [illegible] and finally [illegible] to remove the HCl that will be formed. For example, 2 seconds dwell time at 2000°F and 3% excess oxygen in stack gas or 1 second dwell time at 2700°F and 3% excess oxygen in stack gas.

These facilities should meet the applicable requirements of the state in which they are located and should control effluents within the limits set forth in this standard.

3.5.2.2 Toxic and Hazardous Waste Disposal Sites. Certain landfill sites have been classified by state governments and the federal government as suitable for the disposal of toxic and hazardous liquids. Where such approved sites exist, they may be used for the disposal of liquid wastes described in this standard. (See Appendix A.)

3.5.2.3 Packaging and Shipment.

3.5.2.3.1 Transportation to the disposal facility should be in containers that will prevent leakage and [illegible] the environment.

3.5.2.3.2 [illegible] contents and precautions to drive off gases of the [illegible] ment.

3.5.2.3.3 Containers used for this purpose should not be used for any such materials [illegible] retired from service until they are completely drained. Any

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solvents used in cleaning these containers will be contaminated with askarel and should be disposed of according to the same procedures described in 3.5.2.

3.5.3 Disposal of Solid Wastes. (See 3.5.1 for scrap capacitors.) All solid wastes that have been saturated with askarel should be disposed of by the following procedure:

(1) The saturated wastes should be placed into leakproof containers and transported to a supervised dry landfill site meeting state requirements. Alternatively, they can be disposed of by incineration in state-approved facilities.

(2) Solid absorbents used for spills can be disposed of uncontained in the supervised dry landfill site. transport to the site should be in closed containers. Alternatively, incineration can be used in accordance with 3.5.2. (See Appendix A for a listing of facilities.)

3.6 Labeling. Capacitor units vary greatly in size and in end use or application. Small capacitor units are frequently applied as a component of another piece of equipment, such as a fluorescent lighting ballast, a roadway or area lighting luminaire, a motor, etc. In such applications a label on the capacitor unit referencing approved disposal procedures would not normally be [illegible] when the piece of equipment is disposed of. [illegible] foregoing reasons, [illegible] this standard [illegible] small capacitor units [illegible] and [illegible] capacitor units [illegible] and 3.6.2, respectively.

3.6.1 Small Units. Small units are defined as those that contain [illegible] of askarel. The capacitor manufacturer should affix a label in a conspicuous place, referencing this standard or describing disposal procedures consistent with it. This label should contain, as a minimum, the following information:

"CAUTION. This capacitor contains a polychlorinated biphenyl, (PCB). To avoid possible environmental contamination, it should be [illegible] by approved incineration facility. Dispose of [illegible] requirements. Incineration results in destruction of PCBs. See American National Standard C107.1-1974 for further information. Copies are available from American National Standards Institute, 10 E. 40th Street, New York, N.Y. 10018.

4. Transformer Guidelines

4.1 General

4.1.1 Types of Transformer Askarels.* Askarels of various compositional types are currently in use. For the general properties and types, see ASTM D 2283-73a [20]. Under arcing conditions, the gases produced, though predominantly consisting of noncombustible hydrogen chloride, can contain varying amounts of combustible gases depending upon the askarel type.

4.1.2 Safety Precautions. Based on about 40 years of safe industrial usage, askarels have been considered as relatively harmless materials to humans. There has been no known instance of human injury when askarels are used under the normally prescribed conditions of precaution and handling.

Although it has been generally thought that exposure to askarels is not hazardous provided that simple precautions are taken, exposure should still be avoided or minimized.

4.1.2.1 Vapors. The odor of askarel is noticeable well below the maximum safe air concentrations. Depending upon the composition of the askarel used, from 0.5 to 1.0 milligram per cubic metre of air has been determined to be the upper safe level of exposure during an 8-hour workday. (See reference [9].) The procedure for performing the [illegible] is contained in Section [illegible] Appendix B. The [illegible] should be used.

Breathing vapor or fumes from heated askarel should be avoided. High concentrations of vapors [illegible] eyes, [illegible] upper respiratory tract. Persons shall [illegible] to guard against [illegible] and rapid [illegible] of maintenance operations to avoid open exposure of hot askarels (55°C or greater). The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride, and small percentages of other gases. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarels or its arced products is necessary under emergency conditions, an approved gas mask of the organic canister type, or self-contained breathing apparatus, must be worn. Such exposure should be under the surveillance of [illegible] [illegible] [illegible] [illegible]

* The following trademarks are among those employed by electrical manufacturers to designate the askarels used in their products: Asbestol, Chlorextol, Inerteen, No-Flamol, Pyranol and Saf-T-Kuhl.

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by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators, and replacement parts should have U.S. Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

4.1.2.2 Liquid. In contrast to the situation in which mineral insulating oils are handled, there is no fire hazard in handling askarels. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel, and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should require avoidance of contact with any askarels. The use of porous gloves that can absorb and retain askarels is to be avoided. Resistant gloves and aprons of the neoprene, polyethylene, or fluoroelastomer[7] type should be used if contact is unavoidable. In case of spillage on the clothing, the clothing should be removed as soon as practical, the skin washed, and the clothing laundered.

Medicinal washes or mild detergents followed by the application of cold cream will reduce the irritation resulting from the contact of an open cut or abrasion with askarel.

Safety glasses with side shields or a face shield [illegible] when handling askarels, [illegible] persons reported to ingest askarel [illegible] with large quantities of running water [illegible] needing than examined by a physician [illegible] results. (A drop of [illegible] has been [illegible] to be sure [illegible].)

Persons developing skin irritation or respiratory irritation while working with askarels should be placed under the supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking, or using toilet facilities.

4.1.3 Transport Container Marking. Any container, such as tank cars, tank trucks, drums, cans, etc. used to transport transformer askarels, new or used, should be labeled with the following:

CAUTION: This product contains polychlorinated biphenyls (PCBs). Care should be taken to prevent [illegible] into the environment. [illegible] storage, [illegible] transportation, or disposal of liquid or containers. Avoid prolonged breathing of vapors or mists. Avoid contact with eyes or prolonged contact with skin. If skin contact occurs, remove by washing with soap and water. Following eye contact, flush with water. In case of spillage onto clothing, the clothing should be removed as soon as practical, skin washed, and clothing laundered.

4.1.4 Receiving, Handling, and Storage of Askarels. Askarels are shipped in tank cars, tank trucks, steel drums, metal cans, and test-sample containers. When received, all containers should be inspected for leaks.

4.1.4.1 Storage Tanks. Storage tanks should be erected so that inspection can be made for leaks or spills. Construction should be such that inadvertent leakage or spills are prevented from reaching streams and sanitary or storm sewers.

4.1.4.2 Tank Cars and Tank Trucks. All bulk shipment equipment should be inspected for leaks immediately upon receipt. Drain pans must be provided to prevent spillage from unloading hoses and connections. Askarel liquid collected in drain pans should be placed in drums labeled "SCRAP ASKAREL" for disposition.

4.1.4.3 Steel Drums, Cans, and Test-Sample Containers. On delivery, all such shipments should be carefully inspected for leaks. The containers should be stored indoors in an area especially selected for this purpose. A curb should enclose the area to provide a basin for containing the askarel from one or more containers should the containers be damaged. The area must not have a drain that is connected to a sanitary or storm sewer.

If an indoor storage area is not possible, the containers should be stored under a [illegible].

4.1.5 Control of Water Effluents. The [illegible] is to eliminate askarel in plant water effluent streams. However it is recognized that existing drain systems from manufacturing plants, repair shops, and installation sites may be contaminated as a result of past practices. Other sections of this standard provide that no askarel wastes of any kind be disposed of in any water effluent streams and that accidental spills be prevented from getting into such streams.

4.1.5.1 Concentration Limits. The 1972 Environmental Protection Agency proposals are to keep PCB levels in rivers and lakes below 0.01 part per billion. This is currently under review by the EPA and standards are expected to be promulgated in 1974. Plant effluent streams should be managed and controlled in a manner [illegible] these government standards.

4.1.5.2 Monitoring [illegible] plant effluent [illegible] should be [illegible] consistent with plant situations. The procedure for performing the necessary analyses is contained in Section B4 of Appendix B. This procedure or its equivalent should be used.

[7] For example, Viton.

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4.1.5.3 Methods for Minimizing Effluent Stream Contamination. The ideal approach is to isolate totally all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant.

4.1.6 Disposal Procedures and Services

4.1.6.1 Sources of Materials Requiring Special Handling and Disposal Procedures. Liquids containing PCBs and solids containing or contaminated with PCBs may be obtained from any of the following sources: transport containers, transformer manufacturing processes, in-test failures, liquids contaminated beyond reclamation, in-service transformer leaks and failures, askarel-filled transformers scrapped for any reason, etc.

4.1.6.2 Classification for Disposal of Materials Containing PCBs. In general, there are three types of materials requiring disposal: liquids, burnable solid materials containing PCBs, and nonburnable solid materials contaminated with PCBs.

4.1.6.2.1 Liquids. Liquids containing PCBs requiring disposal by high-temperature incineration may consist of the following:

(1) PCBs contaminated with mineral oil.

(2) Mineral oil contaminated with PCBs.

(3) Nonreclaimable contaminated transformer askarels, used askarels, askarels from manufacturing spills, and drip accumulation, etc., rich in PCBs, and askarels from holding basins, drip and drain pans, washings, sample jars and containers, etc.

4.1.6.2.2 Burnable Solid Waste Materials Containing PCBs. These materials can be disposed of by high-temperature incineration and consist of cellulosic materials, rags, pressboard, wood, sawdust, fuller's earth in bulk or in cloth bags, blotter papers, rolls of cork gaskets, etc.

4.1.6.2.3 Nonburnable Solid Waste Materials Containing, or Contaminated with, PCBs. These materials may consist of coil structures, steel, copper, aluminum filter units of the steel mesh construction type, askarel drums, cans, etc.

Materials of this nature should be allowed to drain with the liquid collected in drip pans, etc. Further removal of adhering PCBs can be accomplished by washing or solvent extraction with kerosene or other approved washing liquids such as perchloroethylene or trichloroethylene. Accumulated liquids can be disposed of as indicated in 4.1.6.2.1. Solid materials may be handled as normal scrap.

4.1.6.3 Shipment of Scrap Liquids for Disposal. All liquid scrap material should be placed in appropriate metal transport drums, properly labeled, for shipment to a company offering an acceptable disposal service.

4.1.6.4 Shipment of Burnable Solid Waste Material Containing PCBs for Disposal. Material of this type should be placed in open-head drums with suitable closures and with the drum properly labeled for shipment to a company offering an acceptable disposal service.

4.1.6.5 Liquid and Solid Waste Disposal Service Organizations

4.1.6.5.1 General. Disposal of askarels and askarel-soaked materials should be accomplished by means in which there is no significant release of askarel to the environment. At present, disposal is accomplished by carefully controlled incineration of liquids and soaked software, and by controlled landfill burial of apparatus and other hardware from which askarel has been previously drained and washed.

Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incineration plus oxygen availability and, finally, suitable scrubbers to remove the HCl that will be formed: for example, 2-second dwell time at 2000°F and 3% excess oxygen in stack gas, or 1.5-second dwell time at 2700°F and 2% oxygen in stack gas.

These facilities should meet the applicable requirements of the state in which they are located and should control effluents within the limits set forth in this standard.

Controlled landfill or deep-well disposal can be used where permitted by federal, state, and local regulations.

4.1.6.5.2 Costs. In addition to the normal costs of collecting scrap liquids and solids for disposal, additional costs borne by the owner of such scrap include shipping containers, cost of transport to the disposal service organization, and a disposal fee usually based upon a per-gallon or per-pound charge.

4.1.6.5.3 Disposal Services. Organizations offering disposal services are listed in Appendix A, including their location, facilities available, types of material handled, and disposal procedures used. Specific shipping directions, disposal procedures, and costs should be obtained from the organization.

4.2 Specific Guidelines

4.2.1 Plant Housekeeping. It is necessary to assume that in filling equipment with askarel, and during further handling of this equipment, an askarel spill may occur. Therefore, it is necessary to provide facilities and a procedure for cleanup to prevent contamination.

4.2.1.1 Askarel Filling Area

4.2.1.1.1 The location of the askarel filling area should be adjacent to the unloading area and final shipping area to minimize the danger of damage of units during handling.

4.2.1.1.2 The main manufacturing area for filling equipment with askarel should be provided with impervious surface floors or suitable basins so con-

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structed that any inadvertent leakage or spills are prevented from reaching streams, sanitary sewers, or storm sewers. All askarel-handling equipment, such as pumps, hoses, etc, shall be of the askarel-resistant type.

4.2.1.1.3 Drip pans shall be provided for hose connections and filling valves.

4.2.1.2 Special Containers for Scrap Materials

4.2.1.2.1 Drums labeled "SCRAP ASKAREL" should be available for handling all spilled and waste askarel from sumps, failed units, drip pans, sample jars, etc.

4.2.1.2.2 Open-head drums with suitable closures and labeled "SCRAP BURNABLE ASKAREL WASTE" should be available for handling contaminated cellulose insulation, rags, paper pressboard, wood, gaskets, sawdust, etc.

4.2.1.2.3 Separate containers for handling steel, copper, and aluminum, each adequately marked, shall be provided for the components of contaminated core and coil assemblies. These containers are required for the various materials when repairing or scrapping assemblies.

4.2.1.2.4 Containers for supplies of material for absorbing small askarel spills or cleanup of larger spills should be provided.

4.2.1.3 Conditioning of Askarels

4.2.1.3.1 Askarel Conditioning Equipment. [illegible] should be located either in the [illegible] of the main transformer manufacturing [illegible] with askarel.

4.2.1.3.2 Fuller's Earth. Conditioning of [illegible] askarel by use of fuller's earth [illegible]. The [illegible] fuller's earth in cartridges or bags when required should be allowed to drain thoroughly over drip pans to remove as much liquid askarel as possible. The cartridge units of steel mesh construction should be placed in the "STEEL CONTAMINATED WITH ASKAREL" container for disposition. Cloth bags filled with fuller's earth should be placed in the "SCRAP BURNABLE ASKAREL WASTE" container for disposition.

4.2.1.4 Teardown of Units for Repair or Scrap

4.2.1.4.1 Drain all askarel from the unit either into a holding tank for reuse or into the drum labeled "SCRAP ASKAREL" for disposition, and then allow sufficient time for all of the askarel to drain from the core and coils.

4.2.1.4.2 Remove the core and coil assembly from the transformer. Sufficient absorbent material should be placed on the floor to absorb any askarel fluid that still drips from the transformer.

4.2.1.4.3 Place all materials in the appropriate salvage containers during the dismantling for later disposition.

4.2.1.4.4 All used materials, including rags, sawdust, tape, etc. regardless of quantity, shall be put into the appropriate containers for disposition.

4.2.2 Transformer Labeling

4.2.2.1 New Transformers. All new transformers that contain PCBs shall have a label of adequate durability, permanency and prominently attached to the tank by the manufacturer, giving adequate warning and instructions. A suggested label includes the following:

CAUTION: The insulating liquid in this transformer contains polychlorinated biphenyls (PCBs). Care should be taken to prevent entry into the environment. In case of malfunction or leaks, consult the instruction manual or the manufacturer.

4.2.2.2 In-Service Transformers. The transformer manufacturer should make available suitable labels with similar warning as shown in 4.2.2.1 for use on existing transformers.

4.2.3 Information for Transformer Users

4.2.3.1 General. Askarel-filled transformers are delivered to customers as sealed units from which there is no escape of askarel under normal operation. Although certain types of equipment failures can permit loss of some askarel to the environment, such cases are extremely rare.

4.2.3.2 Transportation and Receiving. [illegible] upon receipt of the equipment and follow up on transportation or handling accident that may affect the integrity of the [illegible] warnings or labels on the transportation vehicle. [illegible] and fittings should be examined for any leakage or spillage that may have occurred in shipping. If leakage is evident, the cause should be corrected and the spillage treated with absorbent materials such as sawdust, followed by a cleanup of the affected area with rags soaked with kerosene or other approved solvent such as perchloroethylene or trichloroethylene. All materials used should be collected for proper disposition as described in 4.1.6.

4.2.3.3 Installation and Periodic Inspection. Following installation, the unit should again be inspected for any damage or leakage. It is recommended that periodic in-service inspections be made for any leaks.

4.2.3.4 Filling, Filtering, or Drying Askarel. Most askarel units are shipped with the proper amount of askarel, but if it becomes necessary to top off a unit, the manufacturer's instructions should be followed.

If it is necessary to dry an askarel unit [illegible] treat an askarel unit with fuller's earth, [illegible] should be followed. When filtering or conditioning [illegible] of the precautions previously described for drip pans, proper disposal of filter media etc. apply.

4.2.3.5 Sampling. It is common practice to sample askarel from a transformer for periodic maintenance testing. As previously described, such samples should be

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taken in a manner to avoid any contamination of the environment. Washings should be collected for proper disposal. Field and laboratory test samples, washings, etc, should also be collected for proper disposal.

4.2.3.6 Transformer Disposal. The ultimate disposal of an askarel-filled transformer may be accomplished in either of two ways:

(1) Complete drainage and dismantling with the proper disposal of the askarel and askarel-soaked components as described in 4.1.6.

(2) Disposition of askarel transformers by means of junk or scrap dealers. This should be avoided unless a transformer is first drained, followed by soaking the interior with a suitable solvent. Accumulated liquids and washings are to be disposed of as described in 4.1.6.

5. References

5.1 References to the Text

[1] Standard Method of Test for Rapid Gas Chromatographic Estimation of Higher Boiling Homologues of Chlorinated Biphenyls for Class for Askarels. ASTM D 3303-74

[2] American National Standard Method of Test for [illegible] Gravity of Askarels. [illegible] (ASTM D [illegible])

[3] American National Standard Method of Test for Neutralization Number by [illegible] Titration. Z11.3[illegible]-1974 (R1974) (ASTM D [illegible]-73), IP 139/65)

[4] American National Standard Method of Test for Neutralization Number by Potentiometric Titration. Z11.59-1958 (R1971) (ASTM D 664-58 (1968), IP 177/64)

[5] Standard Method of Test for Density of Rubber Chemicals, ASTM D 1817-66 (1972)

[6] American National Standard Method of Test for Inorganic Chlorides in Askarels. C59.55-1963 (R1973) (ASTM D 1821-63 (1973))

[7] American National Standard Method of Test for Pour Point of Petroleum Oils. Z11.5-1966 (R1972) (ASTM D 97-66 (1971), IP 15/67)

[8] American National Standard Method of Test for Power Factor and Dielectric Constant of Electrical Insulating Liquids. C59.20-1967 (R1973) (ASTM D 924-65 (1973))

[9] American National Standard Method of Test for Specific Resistance (Resistivity) of Electrical Insulating Liquids. C59.51-1965 (R1973) (ASTM D 1169-64 (1973))

[10] American National Standard Method of Test for Hydrolyzable Chlorine Compounds in Chlorinated Aromatic Hydrocarbons (Askarels), C59.106-1970 (ASTM D 1820-65 (1971))

[11] American National Standard Method of Test for Thermal Stability of Chlorinated Aromatic Hydrocarbons (Askarels), C59.111-1970 (ASTM D 1936-64 (1971))

[12] American National Standard Method of Test for Distillation of Road Tars, A37.9-1974 (ASTM D20-72)

[13] American National Standard Methods of Testing Electrical Insulating Oils, C59.2-1974 (ASTM D 117-71 (1973))

[14] American National Standard Method of Test for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes, C59.19-1968 (R1973) (ASTM D 877-67 (1971))

[15] American National Standard Method of Test for Flash and Fire Points by Cleveland Open Cup, Z11.6-1973 (ASTM D 92-72, IP 36/67)

[16] American National Standard Method of Test for Saybolt Viscosity, Z11.2-1956 (R[illegible]) (ASTM D [illegible]-56 (1973))

[17] American National Standard Method of Test for Coefficient of Thermal Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels, C59.57-1965 (R1973) (ASTM D 1903-63 (1973))

[18] MÜNCH, R. H. Measuring the dissipation factor, dielectric constant, and resistivity of liquids. *Insulation Circuits*, vol 16, Mar 1970, pp 46–49.

[19] Chlorodiphenyls. *Hygienic Guide Series*. Westmont, N.J.: American Industrial Hygene Association, Jan–Feb 1965.

[20] Standard Specification for Chlorinated Aromatic Hydrocarbons (Askarels) for Transformers, ASTM D 2283-73a

5.2 General References

Aroclor® Polychlorinated Polyphenyls (Biphenyls). Technical Bulletin [illegible]. St. Louis, Monsanto Industrial Chemicals Company, [illegible]

DRINKER, C. K. Further observations on the possible systemic toxicity of certain of the chlorinated hydrocarbons. *Journal of Industrial Hygiene and Toxicology*, vol 21, 1939, pp 155–159.

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DRINKER, C. K.; WARREN, M. F.; and BENNET, G. A. The problem of possible systemic effects from certain chlorinated hydrocarbons. *Journal of Industrial Hygiene and Toxicology*, vol 19, 1937, pp 283–311.

ELKINS, H. B. *The Chemistry of Industrial Toxicology*. New York: John Wiley & Sons, Inc, 1959.

GREENBURG, L.; MAYERS, M. R.; and SMITH, A. R. The systemic effects resulting from exposure to certain chlorinated hydrocarbons. *Journal of Industrial Hygiene and Toxicology*, vol 21, 1939, pp 29–38.

Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment. Cincinnati: American Conference of Governmental Industrial Hygienists, 1973.

TREON, J. F.; CLEVELAND, F. P.; CAPPEL, J.; and ATCHLEY, R. W. The toxicity of the vapors of Aroclor 1242 and Aroclor 1254. *American Industrial Hygiene Association Quarterly*, vol 17, 1956, pp 204–213.

6. Revision of American National Standards Referred to in This Document

When the American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

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Appendixes

(These Appendixes are not a part of American National Standard Guidelines for Handling and Disposal of Capacitor- and Transformer-Grade Askarels Containing Polychlorinated Diphenyls, C107.1-1974, but are included for information purposes only.)

Appendix A

Disposal Services

In addition to the supervised dry landfill sites that may be used for the disposal of askarel-containing scrap, the following additional known facilities and services have been established, and others may be available.[1]

Chem-Trol Pollution Services, Inc
P.O. Box 200
1550 Balmer Road
Model City, N.Y. 14107
Phone: 716 754-8231

This organization has facilities and services capable of handling:

(1) Liquids. Askarels alone or mixed with solvents or oils. Disposal by high-temperature incineration.

(2) Solids (software). Askarel-soaked compounds, rags, cartons, absorbing earths, etc. Disposal by incineration at combustion temperatures up to 2500°F. Incineration gases are scrubbed, and entrained solids are removed before exhausting to air.

(3) Solids (hardware). Capacitors, transformer tanks, other askarel-soaked metals. Disposal by scientific landfill. Has solvent extraction capability.

Monsanto Company
800 North Lindbergh Boulevard
St. Louis, Mo 63166
Phone: 314 694-3352

This organization has facilities and services capable of handling askarel liquids alone or mixed with other oils or solvents by high-temperature incineration. Liquid is pumped through a gun with atomizing steam into incinerator. Temperatures are maintained at 2000°F-2500°F with auxiliary natural gas. Exit gases are quenched to 180°F by contact with water. Gas is then passed through a high-energy venturi scrubber for removal of particulate before exhausting to air (110°F). gases are passed through a packed column scrubber to remove HCl.

Nuclear Engineering Company
Eastern Division
P.O. Box 146
Morehead, Ky 40351
Phone: 606 784-6611

Nuclear Engineering Company
Disposal Division
Sheffield, Ill. 61361
Phone: 815 454-2624

This organization provides containerization, transportation and disposal services of all liquids and contaminated hardware. Disposal is in controlled chemical and scientific landfill sites licensed by Atomic Energy Commission for radioactive waste disposal. The organization also has two West Coast locations, in the states of California and Washington.

Rollins Environmental Services, Inc
P.O. Box 2349
Wilmington, Del 19899
Phone. 302 658-8451

This organization has facilities and services capable of handling:

(1) Liquids. Askarel alone or mixed with solvents or oils. Disposal is by high-temperature incineration.

(2) Solids (software). Askarel-soaked compounds, rags, cartons, absorbing earths, etc. Disposal is by incineration at combustion temperatures up to 2500°F. Incineration gases are scrubbed, and entrained solids are removed before exhausting to air.

Rollins Environmental Services maintains disposal facilities in the following areas.

Philadelphia, Camden:
Rollins Environmental Services, Inc
Route 322
Logan Township
Bridgeport, N.J. 08014

[1] The listing given herein is representative of some of the sources that provide this service, and is not presumed to be complete. Any other organizations that wish to be listed should notify the Standards Institute so that they may be included in the next edition of this standard.

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APPENDIX

Baton Rouge:
Rollins Environmental Services, Inc
Scenic Highway & West Cheatham Lane
Scotlandville
East Baton Rouge Parish, La 70807

Houston:
Rollins Environmental Services, Inc
Tidal Road & Highway 134
Deer Park, Tex 77536

Appendix B

Analytical Procedures and Laboratory Service Organizations

B1. General

Analytical procedures for determining PCBs in air, water, and sediments are given in Sections B3 and B4.

B2. Laboratories

The following laboratories are representative of those offering services for PCB analysis.[1]

[illegible] Corporation
[illegible] East [illegible] Street
La Salle, Illinois 61301
Phone: [illegible] 223-1500

[illegible] Inc. (Subsidiary of [illegible] Corporation)
6132 West Fond du Lac Avenue
Milwaukee, Wis 53218
Phone: 414 461-9500

Gollob Analytical Service Corporation
47 Industrial Road
Berkeley Heights, N.J. 07922
Phone: 201 464-3331

B3. An Analytical Procedure for the Determination of Airborne PCBs

B3.1 Scope. This procedure is based on techniques used by the Monsanto Industrial Chemical Company for the isolation and determination of PCBs in water, soil/sediment, and biological materials. Absolute confirmation of PCB structures is not obtained with this method. Where needed, additional structure proof should be obtained using techniques such as mass spectrometry for further identification of gas chromatography fractions.

B3.2 Principle. Airborne PCBs are collected by drawing a measured volume of air through a [illegible] containing [illegible] and [illegible]. After a suitable amount of air is sampled, the absorbing solvent is diluted or concentrated, and interfering components, if present, are removed by chemical treatment and column absorption chromatography. The amount and type of PCBs present is determined by dual-column capture gas chromatography (GC/GC).

B3.3 Reagents

(1) Hexane: Pesticide grade.

(2) Toluene: Pesticide grade.

(3) Sodium sulfate: Anhydrous, granular, analytical reagent (AR) grade. Heat at 400°C for 1 hour prior to use.

(4) Alumina adsorption: For chromatographic analysis, 80/200 mesh. Heat at 400°C for a minimum period of 4 hours and deactivate with 5% (w/w) distilled water.

For alumina column preparation fill a chromatographic column with hexane up to the point where the reservoir joins the column, and push a glass wool plug to the bottom with a glass rod. In a 50-ml beaker measure 35 ml [illegible] of 30 grams of deactivated alumina, and pour this slowly into the column. Tap or vibrate the column to settle the alumina, and top the alumina with 2 to 3 cm of anhydrous sodium sulfate. Wash the column with 50 to 100 ml of hexane prior to the addition of the sample.

(5) Distilled water: Extracted with hexane to re-

[1] The listing given herein is representative of some of the sources that provide this service, and is not presumed to be complete. Any other organizations that wish to be listed should notify the Standards Institute so that they may be included in the next edition of this standard.

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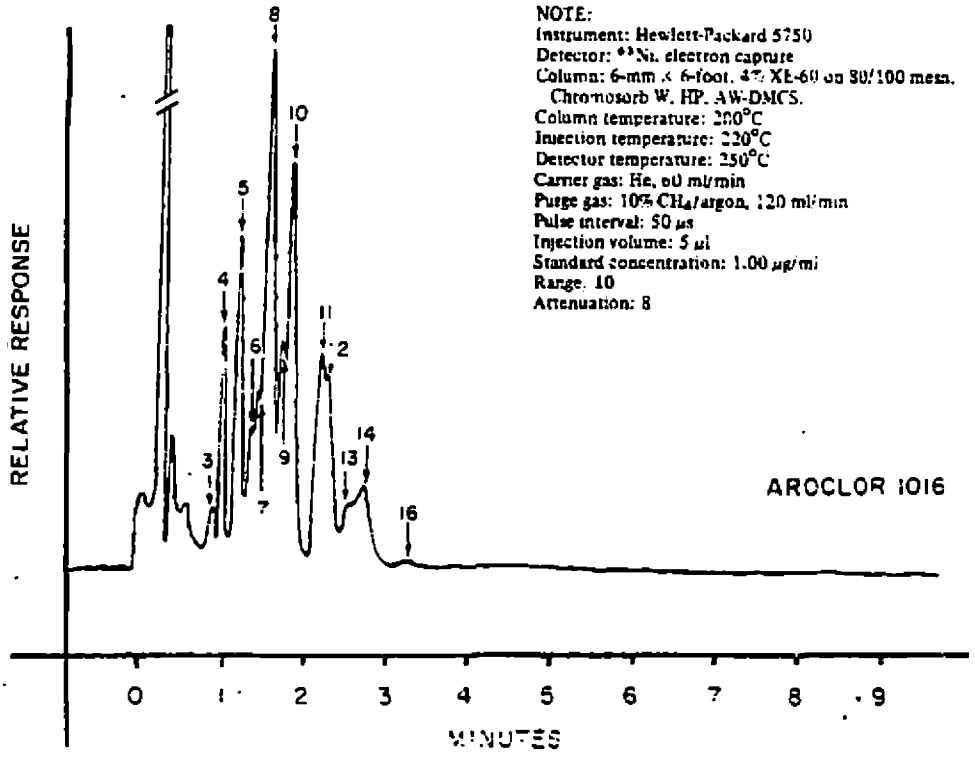


Fig. B1
Aroclor 1016 Electron Capture Chromatogram.

move hexane-soluble electron capturing impurities.

(6) Sulfuric acid: AR grade specific gravity = 1.84.

(7) Potassium hydroxide: AR grade.

(8) Ethanol: Formula 2B.

(9) Alcoholic potassium hydroxide, 2.5% (w/v): Dissolve about 12.5 grams of AR grade KOH in 500 ml of ethanol.

(10) Sulfuric acid–water, 9:1 (v/v): Carefully add 270 ml of AR grade sulfuric acid to 30 ml of distilled water in a 500-ml iced beaker.

(11) PCB standards: Aroclor 1016, 1221, 1242, 1248, 1254, and 1260. (See Fig. B1 through B7.)

B3.4 Apparatus

(1) Gas scrubbing bottles, high form, ground-glass joint, fritted coarse disks.

(2) Separatory funnels equipped with ground-glass stoppers and TFE-fluorocarbon stopcocks: capacities of 125, 250, 500, 1000, and 2000 ml.

(3) Kuderna-Danish evaporative concentrators, 500-ml capacity, equipped with three-ball Snyder columns and graduated 5-ml capacity vials.

(4) Chromatographic columns, glass, 10 inches × 20 mm (OD), with a 5-inch × 50-mm (OD) reservoir at the top, equipped with TFE-fluorocarbon stopcocks.

(5) Flat-bottomed boiling flasks, 125 ml capacity.

(6) Liebig condenser, 200 mm in length.

(7) Hot plates.

(8) Water bath.

(9) 10-µl syringes.

(10) Dry-test meter or wet-test gas meter.

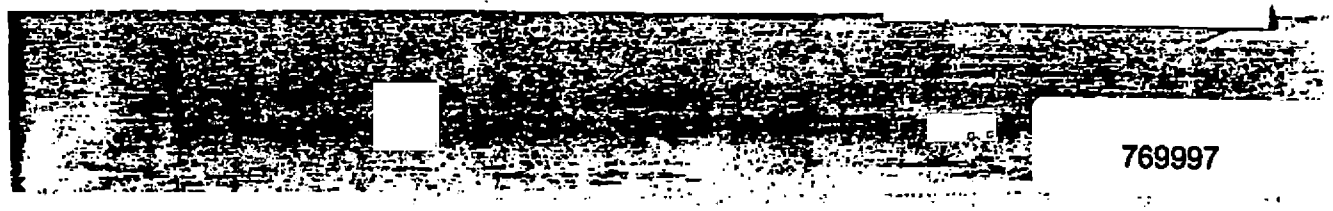
(11) Laboratory vacuum pump.

(12) Rotating vacuum evaporator.

(13) Usual laboratory glassware.

B3.5 Sampling. The air to be sampled for airborne PCBs is drawn through a gas scrubber (or scrubbers) and a dry-test meter using a laboratory vacuum pump. See Fig. B8. The sampling flow rate is controlled by bleeding in air via a needle valve located between the

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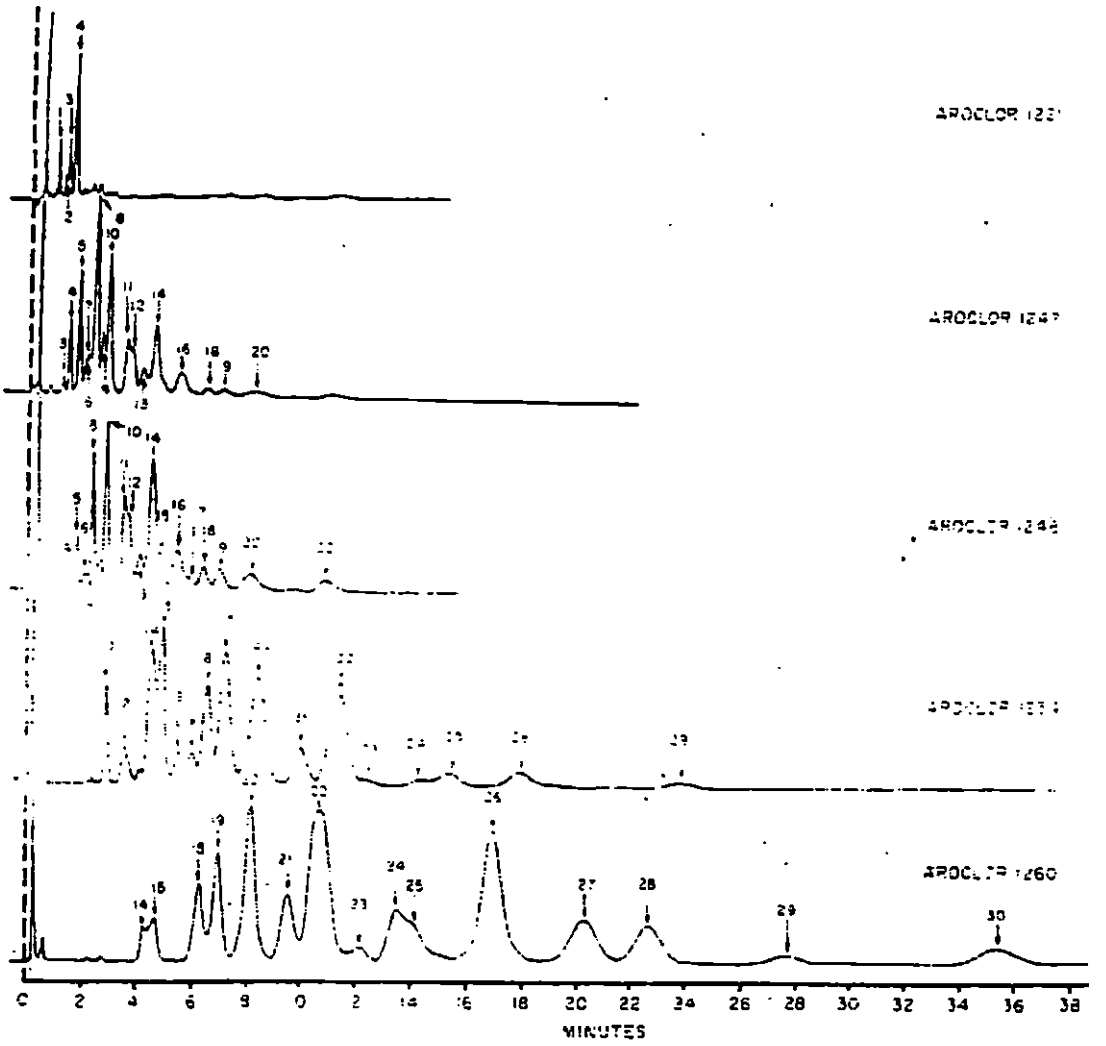


Fig. B2
Comparison of Electron Capture Chromatograms for
Aroclor 1221, 1242, 1248, 1254, and 1260

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NOTE:
Instrument: Hewlett-Packard 5750
Detector: ^{63}Ni electron capture
Column: 6-mm × 6-foot, 4% XE-60 on 80/100 mesh, Chromosorb W, HP, AW-DMCS
Column temperature: 170°C
Injection temperature: 220°C
Detector temperature: 250°C
Carrier gas: He, 60 ml/min
Purge gas: 10% CH_4, argon, 120 ml/min
Pulse interval: 50 µs
Injection volume: 5 µl
Standard concentration: 1.48 µg/ml
Range: 10
Attenuation: 4

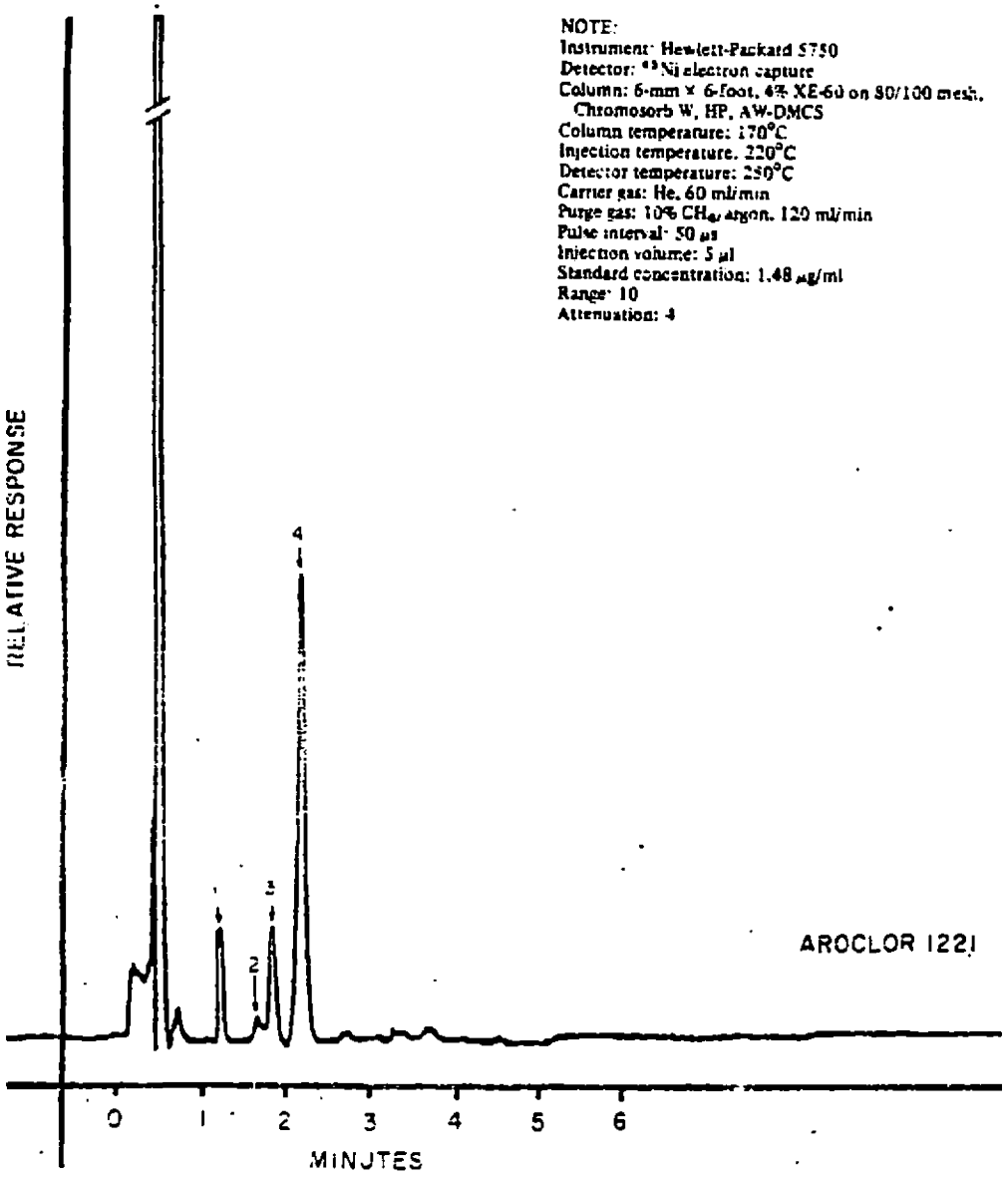


Fig. 93
Aroclor 1221 at Nickel Capture Chromatogram

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NOTE:
Instrument: Hewlett-Packard 5750
Detector: ^{63}Ni electron capture
Column: 6-mm × 6-foot, 4% XE-60 on 80/100 mesh, Chromosorb W HP, AW-DMCS
Column temperature: 190°C
Injection temperature: 22 °C
Detector temperature: 250°C
Carrier gas: He, 60 ml/min
Purge gas: 10% CH_4/argon, 120 ml/min
Pulse interval: 50 µs
Injection volume: 5 µl
Standard concentration: 1.03 µg/ml
Range: 10
Attenuation: 8

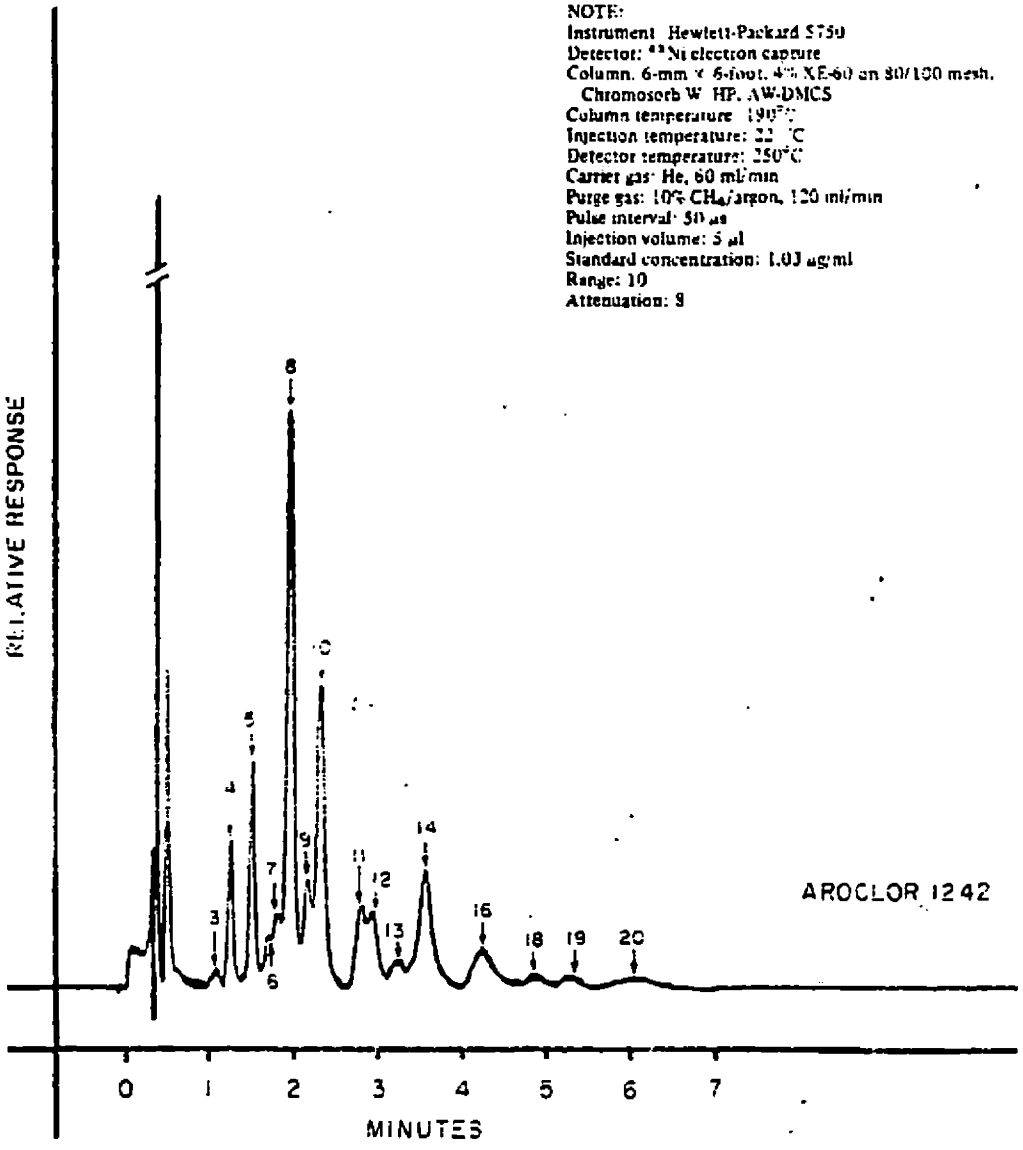


Fig. B4
Aroclor 1242 Electron Capture Chromatogram

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NOTE:
Instrument: Hewlett-Packard 5750
Detector: ^{63}Ni electron capture
Column: 6-mm x 6-foot, [illegible] XE-60 on 80/100 mesh, Chromosorb W, HP, AW-DMCS
Column temperature: 190°C
Injection temperature: 220°C
Detector temperature: 250°C
Carrier gas: He, 60 ml/min
Purge gas: 10% CH_4/argon, 120 ml/min
Pulse interval: 50 μs
Injection volume: 5 μl
Standard concentration: 1.31 μg/ml
Range: 10
Attenuation: 4

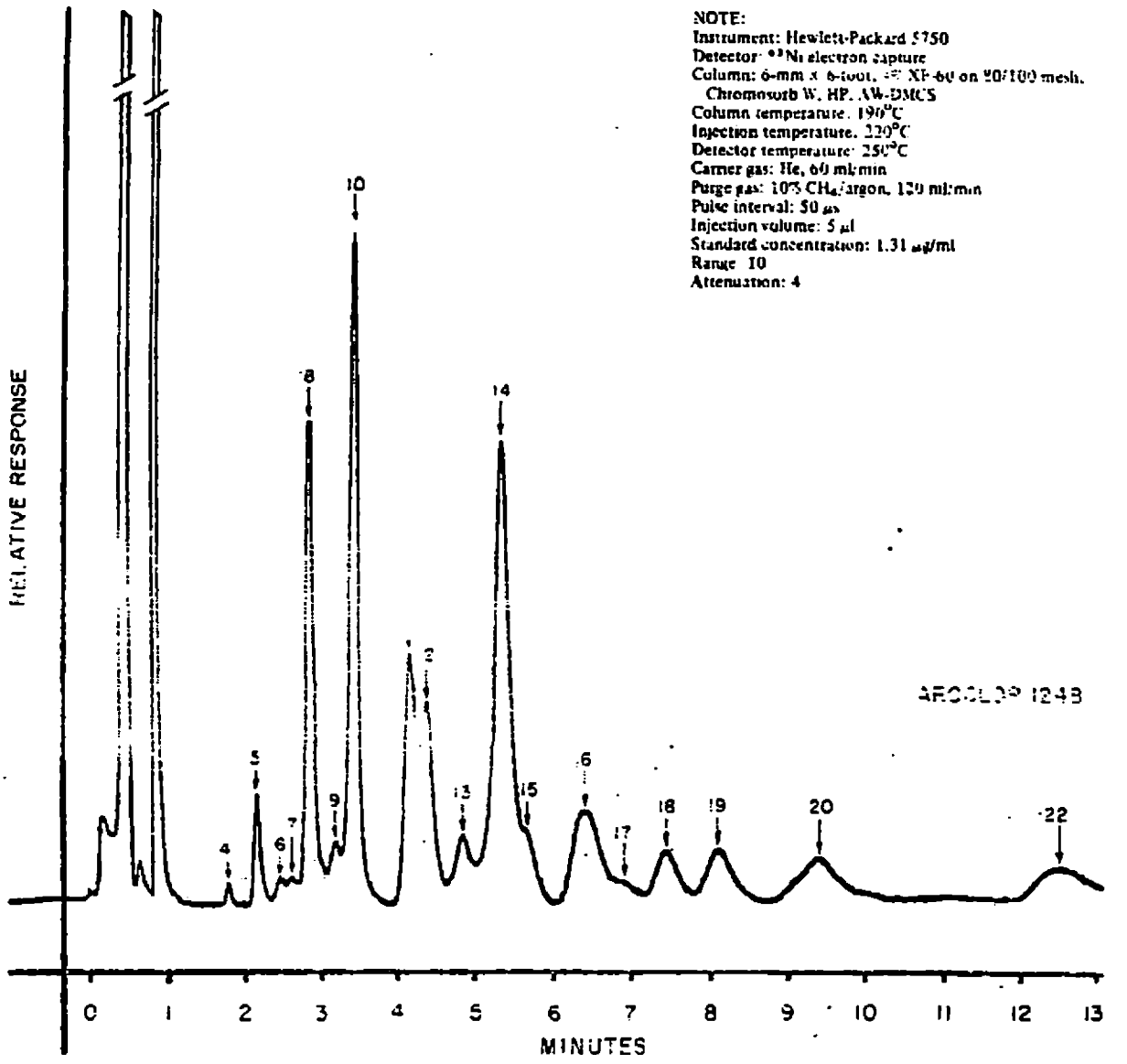


Fig. 35
Aroclor 12[illegible] Electron Capture Chromatogram

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NOTE:
Instrument: Hewlett-Packard 5750
Detector: ^{63}Ni electron capture
Column: 6-mm × 6-foot, 4% XE-60 on 80/100 mesh, Chromosorb W, HP, AW-DMCS
Column temperature: 205°C
Injection temperature: 220°C
Detector temperature: 250°C
Carrier gas: He, 60 ml/min
Purge gas: 10% CH_4/argon, 120 ml/min
Pulse interval: 50 μs
Injection volume: 5 μl
Standard concentration: 1.02 μg/ml
Range: 10
Attenuation: 8

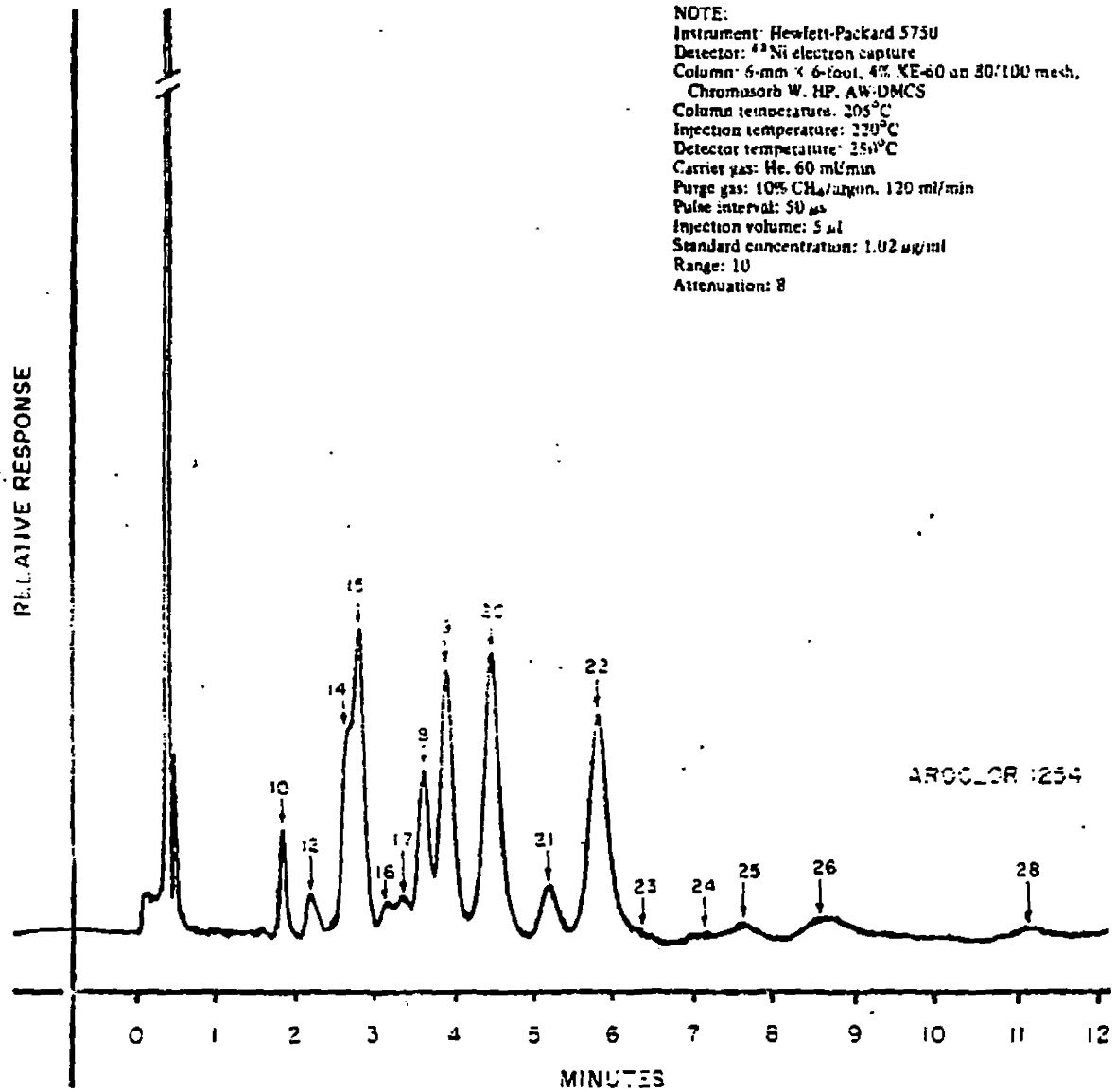


Fig. 5A
Aroclor 1254 Electron Capture Chromatogram

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NOTE:
Instrument: Hewlett-Packard 5750
Detector: ^{63}Ni electron capture
Column: 6-mm x 6-foot, 4% XE-60 on 80/100 mesh, Chromosorb W, HP, AW-DMCS
Column temperature, 220°C
Injection temperature, 220°C
Detector temperature: 250°C
Carrier gas, He, 60 ml/min
Purge gas: 10% CH_4/argon, 120 ml/min
Pulse interval: 50 µs
Injection volume: 5 µl
Standard concentration: 0.98 µg/ml
Range: 10
Attenuation: 8

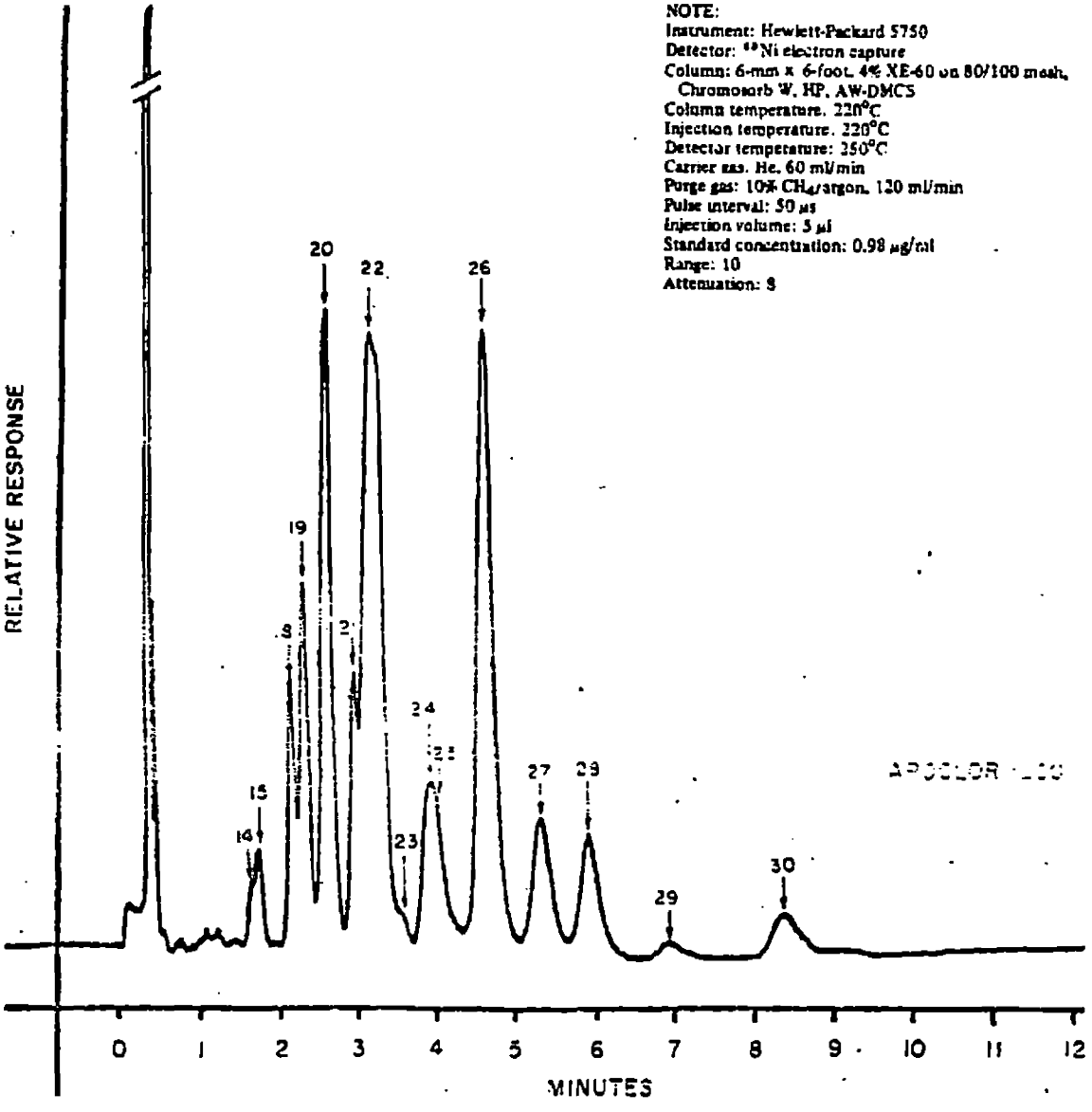


Fig. B
Aroclor 1260 Electron Capture Chromatogram

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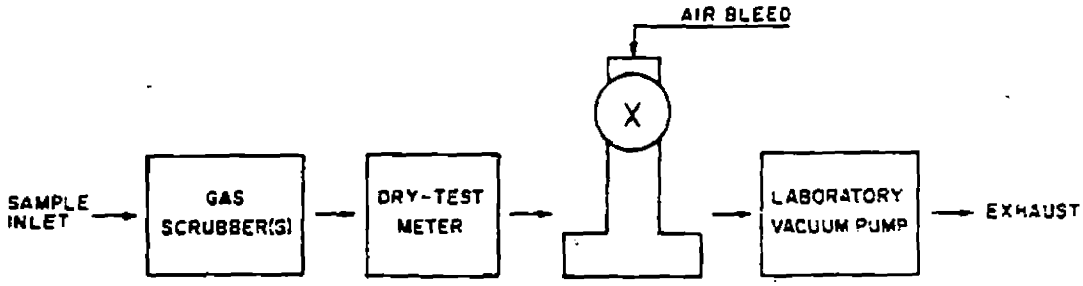


Fig. B8
Sampling Train

pump and the meter. At the end of the sampling period, the metered gas volumes are corrected for temperature and pressure to cubic metres at 25°C and 760 mmHg.

It is important to note that neither the capacity nor the efficiency of the gas scrubber(s) for removal of airborne PCBs have been experimentally evaluated. For this reason, it is best to minimize the sampling flow rate and maximize the sampling time period to obtain measurable amounts of PBCs. When high flow rates must be employed or larger capacity may be needed, it is recommended that several gas scrubbers be used in tandem.

It is cautioned that until the efficiency and capacity of the above gas scrubber have been experimentally established, this procedure should be used only to monitor relative PCB levels sampled under equivalent conditions.

B3.6 Procedure

(1) After scrubbing the desired amount of air, record the metered volume, pressure, and temperature.

(2) Quantitatively transfer the scrubbing solvent to a round-bottomed flask and reduce the volume to approximately 2 ml by rotary vacuum evaporation.

(3) Quantitatively transfer the concentrate to a 30-ml beaker with the aid of several small portions of toluene.

(4) Inject a fraction of a microlitre of the concentrate into the gas chromatograph to check for interferences and determine the approximate level of PCBs present. If no interferences are present, dilute or concentrate the sample to a known volume of toluene as by the electron capture chromatogram, and proceed with the gas chromatographic analysis.

(5) If interferences are present, proceed with the chemical treatment and column chromatographic cleanup procedures.

(6) Transfer the concentrate to a 125-ml extraction flask with the aid of several small portions of solvent.

(7) Evaporate the concentrate just to dryness with a gentle stream of dry, filtered air and add 25 ml of 2.5% alcoholic potassium hydroxide.

(8) Add a boiling chip, put a water condenser in place, and allow the solution to reflux for 45 minutes.

(9) After cooling, transfer the solution to a 250-ml separatory funnel with the aid of 25 ml of distilled water.

(10) Rinse the extraction flask with 25 ml of hexane and add it to the separatory funnel.

(11) Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate and transfer the lower aqueous phase to a second separatory funnel.

(12) Extract the saponification solution with a second 25-ml portion of hexane. After the layers have separated, add the first hexane extract to the second separatory funnel, and transfer the aqueous alcohol layer to the original separatory funnel.

(13) Repeat the extraction with a third 25-ml portion of hexane. Discard the saponification solution and combine the hexane extracts.

(14) Carefully add 25 ml of the sulfuric acid solution (9:1 concentrated sulfuric acid–water) to the hexane extracts.

(15) Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate, and discard the lower aqueous acid layer. Repeat this step until the acid layer is colorless.

(16) Wash the hexane with a 2% sodium [illegible] solution.

(17) Pour the hexane extract through a dry [illegible] funnel, plugged with glass wool that is covered with a layer of sodium sulfate, into a Kuderna-Danish evaporative concentrator.

(18) Add a small boiling chip, put the Snyder column in place, and reduce the hexane volume to less

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than 5 ml by heating the apparatus in a 80°C to 90°C water bath.

(19) After cooling, remove the 5-ml graduated tube and transfer the hexane extract to an alumina adsorption column, washing it in with several 5-ml portions of hexane.

(20) Carefully add 100 ml of hexane to the column reservoir, and collect the total eluent in either a 250-ml volumetric flask or a Kuderna-Danish evaporative concentrator.

(21) If the column eluent is collected in a volumetric flask, dilute to volume with hexane, and proceed with the gas chromatographic analysis.

(22) If the column eluent is collected in a Kuderna-Danish evaporative concentrator, reduce solvent volume, cool, dilute to volume, and proceed with gas chromatographic analysis.

B3.7 Electron Capture Gas Chromatographic Procedure

(1) Instrument: Gas chromatograph (for example, Hewlett-Packard Model 5750, or the equivalent)

(2) Detector: High-temperature ^{63}Ni, electron capture cell

(3) Column: 6-mm × 6-foot glass column, 4% XE-60 on 80/100 mesh, Chromosorb W, HP, AW-DMCS

(4) Column temperature: 160°C to 190°C

(5) Injection port temperature: 225°C to 250°C

(6) Detector temperature: 300°C

(7) Pulse interval: 50 μs

(8) Flow rates: Helium carrier, [illegible] argon-methane purge (approximately 100 ml/min)

Using Eq. 4 as the determinative step, inject a duplicate 5.0-μl of each solution into the chromatograph. By comparison with standard solutions injected, in duplicate, under the same operating conditions, determine the amount and type of Aroclor using the individual or total peak height and area methods.

B3.8 Sample Concentration. Concentration of sample extracts is necessary, prior to cleanup by chromatographic or chemical means, to reduce sample size and increase sensitivity. The preferred method of concentrating allows minimum loss through volatilization or chemical decomposition and requires a minimum time. The three methods of solvent volume reduction most commonly used are evaporation by exposure to a stream of air, evaporation employing a Kuderna-Danish evaporative concentrator equipped with a Snyder column, and evaporation in a reduced pressure. All three techniques have been used without encountering any significant losses from volatilization or chemical alteration. However, the Kuderna-Danish evaporative concentrator and the stream-of-air methods are easier to use.

B3.9 Column Adsorption Chromatography and Chemical Cleanup. Silica gel, a magnesia silica gel,* and alumina deactivated with 0%, 1.0%, 1.5%, 2.0%, and 5% water were investigated as adsorbants for the elimination of interferences. Alumina (5% water) was found to be more effective and reproducible than either silica gel or a magnesia silica gel.[9] The activity of alumina varies with age and lot, therefore, 5% water was added to the alumina, after heating for a minimum of 4 hours at 400°C, to ensure a reproducible activity.

Saponification, and subsequent extraction of the sample with sulfuric acid, is an effective way to remove a number of chlorinated hydrocarbon interferences as well as other matrix interferences. PCBs are not affected.

B3.10 Column Performance. Column performance is the key to effective gas chromatographic analysis and, as such, the choice of column materials is particularly important. Ideally, the support employed should be inert, mechanically strong, and of high surface area. Chromosorb W, HP, AW-DMCS fulfills these requirements and is recommended for this work.

A variety of polar and nonpolar liquid phases have been investigated. The following columns have been found to provide adequate separation, etc. for use in PCB analysis by electron capture: [illegible] DC-200 SE-52, OV-17, SE-30, SE-54, XE-60, Apiezon L, and [illegible] QF-1, DC-200 and XE-60 or QF-1 have been found to be the most suitable of these liquid phases.

Another important consideration when working with an extremely sensitive detector and, consequently, low levels of materials is column conditioning. With polar phases such as XE-60 and QF-1, operating a new column overnight at a temperature 25°C to 50°C higher than that to be used during analysis results in a more stable column. A no-flow conditioning technique is employed to condition nonpolar columns. The column is purged with carrier gas, heated for 30 minutes at an elevated temperature without carrier flow, and then cooled to room temperature. At the end of this cycle, the carrier flow is resumed and the conditioning is completed as in the case of the polar liquid phase. Two precautions should be observed: during conditioning, the column should not be connected to the detector, and the maximum safe temperature of the liquid phase should not be exceeded.

Since all liquid substrates bleed to one degree or another and columns eventually degrade, all new columns should be characterized with [illegible] performance indicators: the number of theoretical plates (N) and a tailing factor (T). p,p'-DDT is employed to check these parameters because it is known to degrade on

*For example, Florisil.

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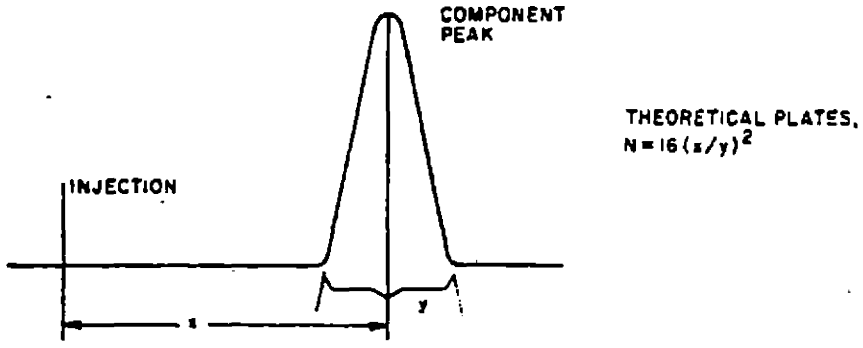


Fig. B9
Calculating Column Efficiency

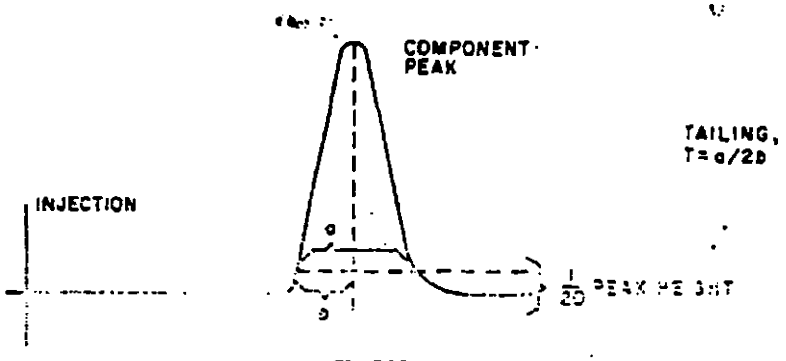


Fig. B10
Calculating the Tailing Factor

"poor" columns. In this manner, one can determine whether the performance of a new column is satisfactory and when the column performance begins to fall off. A column is considered good if the number of theoretical plates per foot is of the order of 400 to 500, with tailing factors of 1.0 to 1.3. Calculation of these parameters is shown in Fig. B9 and B10. Additionally, there should be no significant extraneous peaks upon injection of a pure p,p'-DDT standard.

Other chromatographic conditions that can be adjusted are column temperature and flow rates. Although resolution of a mixture increases with decreasing temperature, a temperature should be chosen that allows the elution of all components within a convenient time period. The flow rates shown are optimum for a given instrument, column, and detector system. These should be adjusted if better results can be achieved.

Any system of instrument and column suitable for chlorinated pesticide analysis is satisfactory for PCB analysis. The use of the high-temperature ^{63}Ni electron capture cell is highly recommended. The ability to operate at higher temperatures prevents maintenance problems due to contamination from high-boiling components. Glass columns also should be employed.

B3.11 Detection and Measurement. Quantitative determinations employing the electron capture detector are nonstoichiometric measurements made by comparing peak heights or areas for solutions of unknown concentrations with those for solutions of standards. The two most common methods employed for peak height or area quantification procedures have been employed:

Case 1. EC gas chromatogram of PCB unknown, unchanged with respect to standard PCB with no evidence of interferences

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Case II. EC gas chromatogram of PCB unknown, altered with respect to standard PCB with no evidence of interferences

Case III. EC gas chromatogram of PCB unknown, unchanged with respect to standard PCB with evidence of interference

The amount of PCBs in Case I samples is determined by preparing a plot of the major peak height or area versus concentration. With Case III samples, a peak free from interference is used. When dominant interferences are present, one or more of the chemical cleanup procedures is employed.

In all cases, the response of the electron capture detector must be linear for quantitative analysis.

B3.12 Contamination. In determining PCBs in biological materials by electron capture gas chromatography, laboratory sources of contamination can be a major problem. The samples and extracts should never be allowed to come in contact with materials other than glass, TFE-fluorocarbon, or metal. Laboratory glassware should be thoroughly washed with hot, soapy water, and rinsed with distilled water, acetone, and then hexane. All equipment should also be rinsed again with hexane just prior to use, and blanks should be frequently carried through all steps of the procedures to ensure against the possibility of contamination.

B3.13 Sensitivity

(1) Concentration: 2 ppb (parts per billion).

(2) Absolute sensitivity: 0.5×10^{-9} gram.

(3) Volume injected: 5 µl

(4) Final volume of extract: 5 ml

(5) Sample size: 250 ml

B4. Analysis of Water and Sediment for PCBs

B4.1 Scope. This methodology is used by the Monsanto Industrial Chemical Company for the determination of the amount and type of PCBs in water and sediment samples. Absolute confirmation of PCB structures is not obtained with this method. Structure proof can be obtained using additional techniques such as mass spectrometry to further identify the gas chromatography fractions.

B4.2 Principle. The PCBs in water and sediment samples are extracted into an organic solvent. Interfering components are then removed from the extracts by chemical treatment and column adsorption chromatography. The amount and type of PCBs present are determined by electron capture gas chromatography (EC/GC).

B4.3 Reagents

(1) Hexane: Pesticide grade.

(2) Acetonitrile: Pesticide grade.

(3) Sodium sulfate: Anhydrous, granular, analytical reagent (AR) grade. Heat at 400°C for 1 hour prior to use.

(4) Alumina adsorption: For chromatographic analysis, 80/200 mesh. Heat at 400°C for a minimum of 4 hours and deactivate with 5% (w/w) distilled water.

For alumina column preparation fill a chromatographic column with hexane up to the point where the reservoir joins the column, and push a glass wool plug to the bottom with a glass rod. In a 50-ml beaker measure 35 ml (about 30 grams) of deactivated alumina, and pour this slowly into the column. Tap or vibrate the column to settle the alumina, and top the alumina with 2 to 3 cm of anhydrous sodium sulfate. Wash the column with 50 to 100 ml of hexane prior to the addition of the sample.

(5) Distilled water: Extracted with hexane to remove hexane-soluble electron capturing impurities.

(6) Sulfuric acid: AR grade, specific gravity = 1.84.

(7) Potassium hydroxide: AR grade.

(8) Ethanol: Formula 2B.

(9) Alcoholic potassium hydroxide: 2.5% (w/v) [illegible] at 12.5 grams of AR grade KOH in 500 ml of ethanol.

(10) Sulfuric acid-water, 9:1 (v/v). Carefully add 270 ml of AR grade sulfuric acid to 30 ml of distilled water in a 500-ml iced beaker.

(11) PCB standards: Aroclor 1242, 1248, 1254, and 1260. (See Fig. B2 and Fig. B4 through B7.)

B4.4 Apparatus

(1) Separatory funnels equipped with ground-glass stoppers and TFE-fluorocarbon stopcocks; capacities of 125, 250, 500, 1000, and 2000 ml.

(2) Kunderna-Danish evaporative concentrators, 500-ml capacity, equipped with three-ball Snyder columns and graduated 5-ml capacity vials.

(3) Chromatographic columns, glass, 10 inches × 20 mm (OD) with a 5-inch × 50-mm (OD) reservoir at the top, equipped with TFE-fluorocarbon stopcocks.

(4) Sintered glass filter funnels, 600-ml capacity, 90-mm disk diameter, medium porosity.

(5) Flat-bottomed boiling flasks, 125-ml capacity.

(6) [illegible]

(7) [illegible]

(8) Water bath.

(9) Reciprocating variable-speed shaker.

(10) 10-µl syringes.

(11) 32-oz all-glass mortars and pestles.

(12) 8-inch × 12-inch × 2-inch (2-1/2 qt) heat-resistant glass baking dishes.

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(13) U.S. Standard sieve, No. 30.
(14) Usual laboratory glassware.

B4.5 Sampling.-It is to be assumed that a rather wide variety of sampling techniques may be employed in collecting samples submitted for analysis. For this reason, water and sediment samples should be treated as given in B4.5.1 and B4.5.2.

B4.5.1 Water. Where possible, the entire water sample, including the container in which it was collected, should be extracted with hexane. With larger samples, where this is not physically possible, the containers should be simply agitated and a 250-ml portion used for the analysis. (See B4.6.)

B4.5.2 Sediment. Any excess water should be decanted, and the entire sediment transferred to a glass baking dish to air-dry at room temperature. The dried material should be transferred from the dish into a mortar and ground. The ground sediment should be sieved, remixed, and a 250-gram portion taken for analysis. (See B4.7.)

B4.6 Extraction of Water Samples

(1) After agitating, transfer the entire aqueous sample or a 250-ml aliquot into a graduated glass cylinder. Record the volume of the sample and quantitatively transfer it to a separatory funnel with distilled water.

(2) Rinse the graduated cylinder with two 50-ml portions of hexane and add each to the separatory funnel.

(3) Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate, and transfer the lower aqueous phase to a second separatory funnel.

(4) Extract the water sample a second time with a 50-ml portion of hexane. After the layers have separated, add the first hexane extract to the second separatory funnel, and transfer the aqueous layer to the original separatory funnel.

(5) Repeat the extraction with a third 50-ml portion of hexane. Discard the aqueous layer and combine the hexane extracts.

(6) Filter the combined extracts through a 4-inch funnel, plugged with glass wool that is covered with sodium sulfate. Collect the filtrate in a Kuderna-Danish evaporative concentrator, add a small boiling chip, put the Snyder column in place, and reduce the hexane volume to less than 5 ml by heating the apparatus in an 80°C to 90°C water bath. (CAUTION: Solvent vapors must be vented into a hood.)

(7) After cooling, remove the 5-ml graduated tube and transfer the hexane extract to an alumina adsorption column, washing it in with several 5-ml portions of hexane.

(8) Carefully add 100 ml of hexane to the column reservoir, and collect the total eluent in either a 250-ml volumetric flask or a Kuderna-Danish evaporative concentrator.

(9) If the column eluent is collected in a volumetric flask, dilute to volume with hexane, and proceed with the gas chromatographic analysis.

(10) If the column eluent is collected in a Kuderna-Danish evaporative concentrator, reduce solvent volume, cool, dilute to volume, and proceed with the gas chromatographic analysis.

B4.7 Extraction of Sediment and Soil Samples

(1) Decant off any excess water and transfer the entire sediment sample to a glass baking dish. Air-dry at ambient temperature (heat should be applied).

(2) When dry, transfer the soil/sediment to a mortar and grind. Sieve the ground material through a No. 30 mesh sieve and weigh 250 grams (to the nearest 0.01 gram) into a 16-ounce narrow-neck screw-cap (aluminum-foil liner) glass bottle.

(3) Moisten the soil with about 10 ml of water and add 150 ml of acetonitrile. Cap the bottle tightly, and mechanically shake it for a minimum period of 1 hour.

(4) Quantitatively transfer the acetonitrile extract into a 600-ml sintered glass filter funnel containing a 1/4-inch layer of anhydrous sodium sulfate. Collect the filtrate in a 600-ml beaker. (Vacuum filtration may be necessary.)

(5) After the acetonitrile has completely drained into the beaker, wash the bottle twice with 50-ml portions of acetonitrile, adding each wash to the funnel after the previous wash has completely percolated through the sediment.

(6) Quantitatively transfer the extract to a Kuderna-Danish evaporative concentrator, add a small boiling chip, put the Snyder column in place, and reduce the solvent volume to less than 5 ml by heating the apparatus in an 80°C to 90°C water bath. (CAUTION: Solvent vapors must be vented into a hood.)

(7) After cooling, remove the 5-ml graduated tube and transfer the concentrate of extracts to a 125-ml extraction flask with the aid of several small portions of solvent.

(8) Evaporate the extract just to dryness with a gentle stream of dry filtered nitrogen and add 25 ml of 2.5% alcoholic potassium hydroxide.

(9) Add a boiling chip, put a water condenser in place on the flask, and reflux for 45 minutes.

(10) After cooling, transfer the extract to a 250-ml separatory funnel, with the aid of 25 ml of distilled water.

(11) Rinse the extraction flask with 25 ml of hexane and add it to the separatory funnel.

(12) Stopper the separatory funnel and shake it

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vigorously for at least 1 minute. Allow the layers to separate, and transfer the lower aqueous phase to a second separatory funnel.

(13) Extract the saponification solution with a second 25-ml portion of hexane. After the layers have separated, add the first hexane extract to the second separatory funnel and transfer the aqueous alcohol layer to the original separatory funnel.

(14) Repeat the extraction with a third 25-ml portion of hexane. Discard the saponification solution and combine the hexane extracts.

(15) Carefully add 25 ml of the sulfuric acid solution (9:1 concentrated sulfuric acid–water) to the hexane extracts.

(16) Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate, and discard the lower aqueous acid layer. Repeat this step until the acid layer is colorless.

(17) Wash the hexane with a 25-ml portion of water. Discard the water wash.

(18) Filter the hexane extract through a 4-inch funnel, plugged with glass wool that is covered with a layer of sodium sulfate, into a Kuderna-Danish evaporative concentrator.

(19) Add a small boiling chip, put the Snyder column in place, and reduce the hexane volume to less than 5 ml by heating the apparatus in an 85°C to 90°C water bath.

(20) After cooling, remove the 5-ml graduated tube and transfer the hexane extract to an alumina adsorption column, washing it in with several 5-ml portions of hexane.

(21) Carefully add 100 ml of hexane to the column reservoir, and collect the total eluent in either a 250-ml volumetric flask or a Kuderna-Danish evaporative concentrator.

(22) If the column eluent is collected in a volumetric flask, dilute to volume with hexane, and proceed with the gas chromatographic analysis.

(23) If the column eluent is collected in a Kuderna-Danish evaporative concentrator, reduce solvent volume, cool, dilute to volume, and proceed with gas chromatographic analysis.

B4.8 Electron Capture Gas Chromatographic Procedure

(1) Instrument: Gas chromatograph (for example, Hewlett Packard Model 5750, or the equivalent).

(2) Detector: High-temperature ^{63}Ni electron capture cell

(3) Column: 6-mm X 6-foot glass column, 4% XE-60 on 80/100 mesh, Chromosorb W, HP, AW-DMCS

(4) Column temperature: 160°C

(5) Injection port temperature: 195°C

(6) Detector temperature: 300°C

(7) Pulse interval: 50 μs

(8) Flow rates: Helium carrier, approximately 60 ml/min; argon-methane purge, approximately 120 ml/min

Using EC GC as the determinative step, inject, in duplicate, 1 to 10 μl of each solution into the chromatograph. By comparison with standard solutions injected, in duplicate, under the same operating conditions, determine the amount and type of Aroclor using the individual or total peak height and area methods.

The electron capture detector should also be used to guide the isolation procedures. Water and sediment extracts can be checked for the presence of PCBs or interferences, or both, by injection of microlitre portions of the extracts at various points in the extraction and concentration schemes. In this manner it can be determined whether the sample needs to be concentrated or diluted and whether the cleanup procedures should be employed.

B4.9 Extraction. The extraction of PCBs from water, employing hexane as the extractant, has been found to be quantitative and sufficiently simple and rapid for use as a routine procedure.

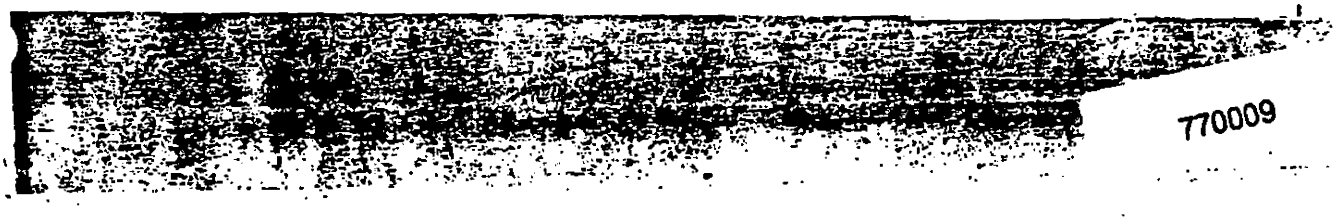
The evaluation of this method was based on spiking water samples with standard acetone solutions of PCB. The spiking method consisted of adding the PCB in 25 to 50 μl of acetone to 500 ml of tap water in a 32-ounce narrow-neck screw-cap jar. After the sample was thoroughly mixed, duplicate 225- to 250-ml aliquots were taken and subjected to the proposed sample preparation and worked up as outlined. The results were quantified by preparing a calibration curve using standard hexane solutions of the PCBs used to spike the water samples. The major isomer peak height was used to construct the calibration plot.

The average recovery and deviation achieved substantiated the applicability of the method for the quantitative recovery and analysis of PCBs from water at the ppb-ppm level.

No PCB recovery experiments from spiked sediment and soil samples have been performed. Instead, several of the residual solids representative of some of the types of sediment or soil analyzed were reextracted with hexane/acetone (40:60) in a soxhlet extractor to test for the efficiency of the acetonitrile extraction step. The hexane after isolation by elution with distilled water, was then subjected to the purification steps. Recoveries by soxhlet extraction have indicated that the acetonitrile extraction of PCBs was essentially quantitative in the cases checked.

B4.10 Sample Concentration. Concentration of sample extracts is necessary, prior to cleanup by chromato-

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graphic or chemical means, to reduce sample size and increase sensitivity. The preferred method of concentrating allows minimum loss through volatilization or chemical decomposition and requires a minimum time. The three methods of solvent volume reduction most commonly used are evaporation by exposure to a stream of air, evaporation employing a Kuderna-Danish evaporative concentrator equipped with a Snyder column, and evaporation under reduced pressure. All three techniques have been used, and no significant losses from volatilization or chemical alteration have been encountered. However, the Kuderna-Danish evaporative concentrator and the stream-of-air methods are easier to use.

B4.11 Column Adsorption Chromatography and Chemical Cleanup. Silica gel, a magnesia silica gel,* and alumina deactivated with 0%, 1.0%, 1.5%, 2.0%, and 5% water were investigated as adsorbants for the elimination of interferences. Alumina (5% water) was found to be more effective and reproducible than either silica gel or a magnesia silica gel.[9] The activity of alumina varies with age and lot; therefore 5% water is added to the alumina, after heating for a minimum of 4 hours at 400°C, to ensure a reproducible activity.

Saponification, and subsequent extraction of the sample with sulfuric acid, is an effective way to remove a number of chlorinated hydrocarbon interferences as well as other matrix interferences. PCBs are not affected.

B4.12 Column Performance. Column performance is the key to effective gas chromatographic analysis and as such the choice of column materials is particularly important. Ideally the support employed should be inert, mechanically strong, and of high surface area. For these reasons, Chromosorb W, HP, AW-DMCS is recommended for this work.

A variety of polar and nonpolar liquid phases have been investigated. The following columns have been found to provide adequate separation, etc., for use in PCB analysis by electron capture: 4% (w/w) DC-200, SF-96, OV-17, SE-30, SE-54, XE-60, Apiezon L, and 6% QF-1. DC-200 and XE-60 or QF-1 are the most suitable of these liquid phases.

Another important consideration when working with an extremely sensitive detector and, consequently, low levels of materials is column conditioning. With polar phases such as XE-60 and QF-1, operating a new column overnight at a temperature 25°C to 50°C higher than that to be used during analysis results in a more stable column. A no-flow conditioning technique is employed to condition nonpolar columns. The column is purged with carrier gas, heated for 30 minutes at an elevated temperature without carrier flow, and then cooled to room temperature. At the end of this cycle, the carrier flow is resumed and the conditioning is completed as in the case of the polar liquid phase. Two precautions should be observed, during conditioning, the column should not be connected to the detector, and the maximum safe temperature of the liquid phase should not be exceeded.

Since all liquid substrates bleed to one degree or another and columns eventually degrade, all new columns should be characterized with two column performance indicators: the number of theoretical plates (N) and a tailing factor (T). p,p'-DDT is employed to check these parameters because it is known to degrade on "poor" columns. In this manner, one can determine whether the performance of a new column is satisfactory and when the column performance begins to fall off. A column is considered good if the number of theoretical plates per foot is of the order of 400 to 500, with tailing factors of 1.0 to 1.3. Calculation of these parameters is shown in Fig. B9 and B10. Additionally, there should be no significant extraneous peaks upon injection of a pure p,p'-DDT standard.

Other chromatographic conditions that can be adjusted are column temperature and flow rates. Although resolution of a mixture increases with decreasing temperature, a temperature should be chosen that allows the elution of all components within a convenient time period. The temperatures given are optimum for 42% chlorinated biphenyl; temperatures are increased when specifically analyzing for the higher chlorinated biphenyls; that is, 54%, 60%, etc. The flow rates shown are optimum for a given instrument, column, and detector system. These should be adjusted if better results can be achieved.

Any system of instrument and column suitable for chlorinated pesticide analysis is satisfactory for PCB analysis. The use of the high-temperature ^{63}Ni electron capture cell is highly recommended. The ability to operate at higher temperatures prevents maintenance problems due to contamination from high-boiling components. Glass columns also should be employed.

B4.13 Detection and Measurement. Quantitative determinations employing the electron capture detector are nonstoichiometric measurements made by comparing peak heights or areas for known concentrations with [illegible]. Except for flash [illegible] measurements are usually more reproducible than peak height measurements but are extremely time consuming unless a recording integrator is employed. However, peak height measurements are as accurate as disk integration or triangulation and, if the

*For example, Florisil.

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peak shape represents a Gaussian curve, the height may be considered independent of the base. Consequently, peak height measurements are generally used. Three variations of the peak height or area quantification procedures have been employed.

Case I. EC gas chromatogram of PCB unknown, unchanged with respect to standard PCB with no evidence of interferences

Case II. EC gas chromatogram of PCB unknown, altered with respect to standard PCB with no evidence of interferences

Case III. EC gas chromatogram of PCB unknown, unchanged with respect to standard PCB with evidence of interference

The amount of PCBs in Case I samples is determined by preparing a plot of the major peak height or area versus concentration. For Case II, a plot is prepared of the total sum of all major peaks versus concentration. With Case III samples, a peak free from interference is used. When dominant interferences are present, one or more of the chemical cleanup procedures is employed.

In all cases, the response of the electron capture detector must be linear for quantitative analysis.

B4.14 Contamination. In determining PCBs in water, soil, and sediment by electron capture gas chromatography, laboratory sources of contamination can be a major problem. The samples and extracts should never be allowed to come in contact with materials other than glass, TFE-fluorocarbon, or metal. Laboratory glassware should be thoroughly washed with hot, soapy water and rinsed with distilled water, acetone, and then hexane. All equipment should also be rinsed again with hexane just prior to use, and blanks should be frequently carried through all steps of the procedures to ensure against the possibility of contamination.

B4.15 Sensitivity

(1) Concentration: 2 ppb
(2) Absolute sensitivity: 0.5×10^{-9} gram
(3) Volume injected: 5 µl
(4) Final volume of extract: 5 ml
(5) Sample size: 250 ml

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American National Standards

The standard in this booklet is one of nearly 5,600 standards approved to date by the American National Standards Institute, formerly the USA Standards Institute.

The Standards Institute provides the machinery for creating voluntary standards. It serves to eliminate duplication of standards activities and to weld conflicting standards into single, nationally accepted standards under the designation "American National Standards."

Each standard represents general agreement among maker, seller, and user groups as to the best current practice with regard to some specific problem. Thus the completed standards cut across the whole fabric of production, distribution, and consumption of goods and services. American National Standards, by reason of Institute procedures, reflect a national consensus of manufacturers, consumers, and scientific, technical, and professional organizations, and governmental agencies. The American standards are used widely by industry and commerce and often by municipal, state, and federal governments.

The Standards Institute, under whose auspices this work is being done, is the United States clearinghouse and coordinating body for standards activity on the national level. It is a federation of trade associations, technical societies, professional groups, and consumer organizations. Some 1,000 companies are affiliated with the Institute as company members.

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For a free list of all American National Standards, write:

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1430 Broadway

New York, New York 10018

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770013

Westinghouse Electric Corporation Power Systems

Distribution Apparatus Division

Box 341
Bloomington, Indiana 47401
(812) 332-4421

October 22, 1976

Mr. J. J. Kark
NEMA
155 East 44th Street
New York, N.Y. 10017

Subject: Negative Ballot, Revised Document, ANSI C107.1 (197_)

Dear Sir:

There is a clear need to distinguish between "goals" and "requirements" particularly with respect to Sections 3.4, 3.4.1, 3.4.1.2, 3.4.1.4 and 4.1.5, 4.1.5.1, 4.1.5.3, 4.1.6.2.2.

Wording of the proposed standard (and in existing C107-1 1964) is acceptable as an expression of goals. However, some environmentalists and others have been inclined to read into this wording a present, mandatory requirement of zero molecules of PCB loss in water effluents. This seems unrealistic in view of the present general status of manufacturing operations, and inconsistent with the present general state of the environment (where statements are appearing that evidence of PCB's is found virtually everywhere). It also seems inconsistent with the probable tolerated levels to be established by the various governing organizations, and inconsistent with environmental need as reflected in the permissible disposal of apparatus, such as ballast capacitors, and the handling of losses by spills.

At the least, wording should be modified to specify present wording to be a goal, and losses in water effluent not to exceed those set by the governing regulatory agency.

In particular, specific changes should be made, as follows:

Clause 3.4.1, last sentence - add parenthetical phrase, "... no askarel wastes of any kind to be disposed of (in bulk) in any water effluent streams...", and add sentence, "Escape of small trace quantities of askarels shall be limited to that established by the appropriate governmental regulatory agency."

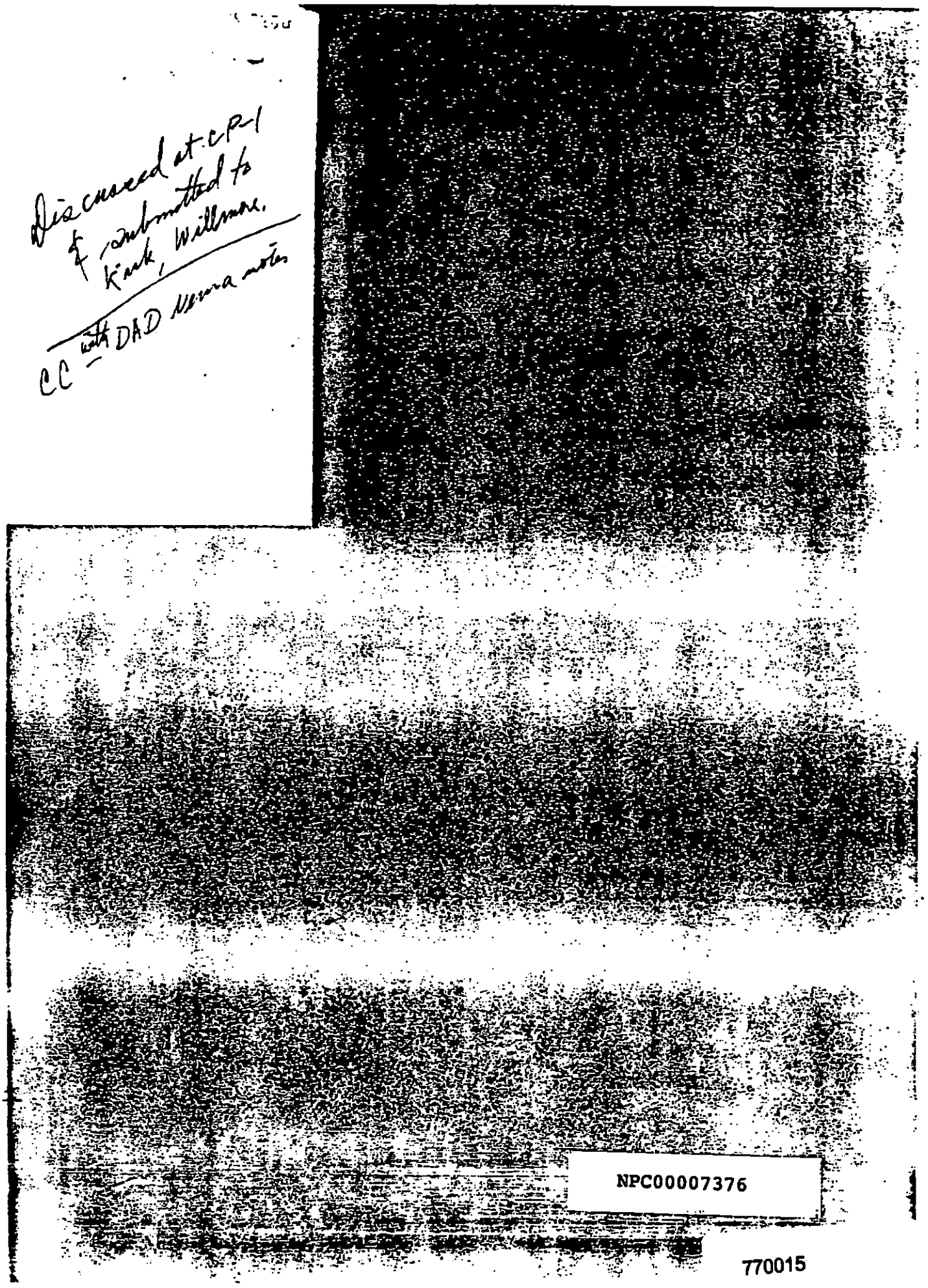
Clause 3.4.1.4: The "ideal approach" is described. It should be stated that ideal solutions to problems are extremely difficult - if not impossible - to achieve, and therefore a minimum practical solution to minimization of effluent stream contamination is therefore given. The following additional sentence is proposed: "As a minimum, effluent streams should have contaminated particulate matter

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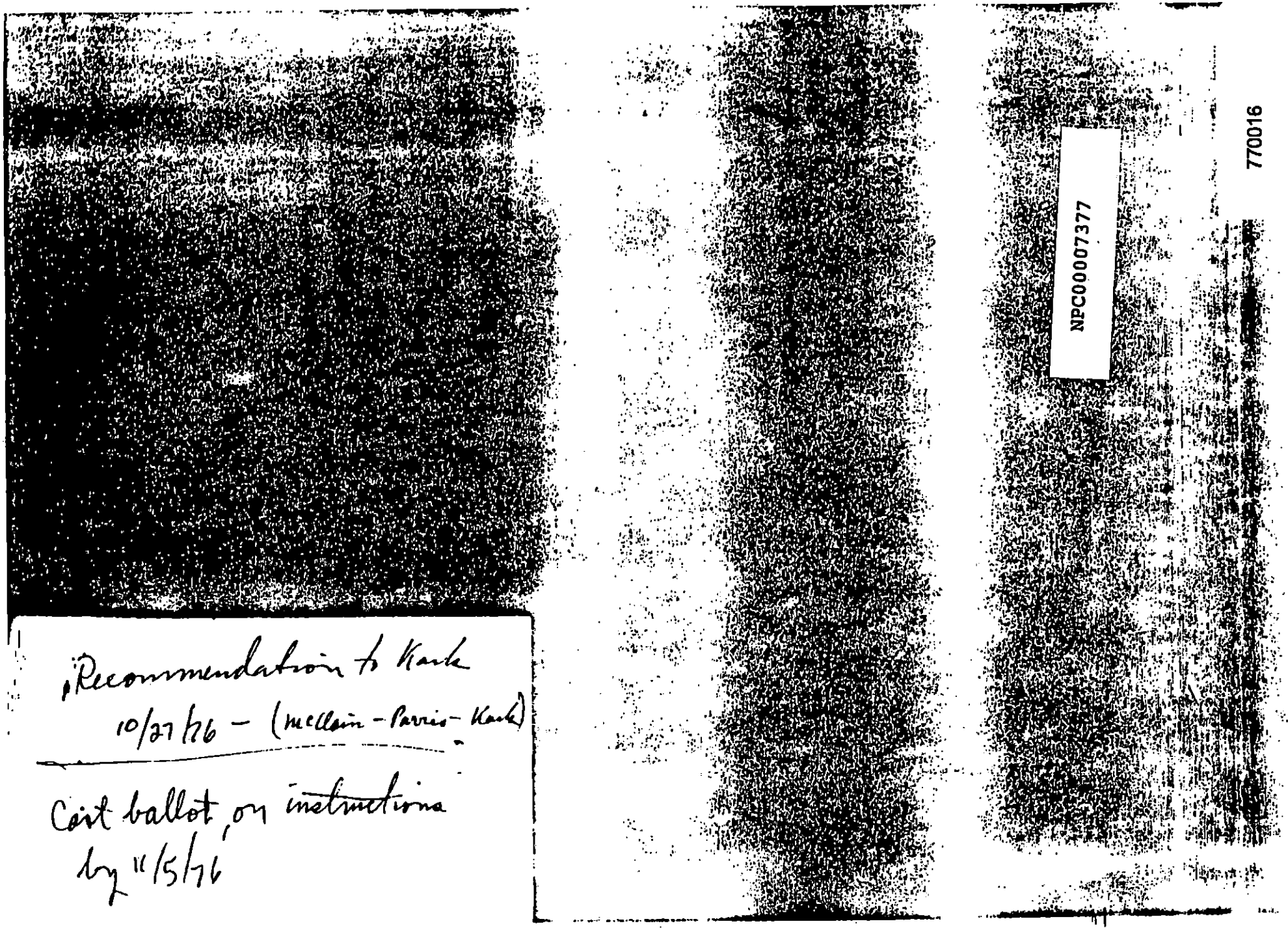
Discussed at CP-1
& submitted to
Kirk, Willmore.

CC with DAD memo notes



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Recommendation to Hauk
10/27/76 – (McClain - Parris - Hauk)

Cert ballot, on instructions
by 11/5/76

PCB - split

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CC - Messrs Sauter, Brittain, Breitweiser, Mercier
Sawyer, Anderson

Westinghouse Electric Corporation Power Systems

Distribution Apparatus Division

Box 341
Bloomington Indiana 47401
(812) 332-4421

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separated for disposal, and concentrations of soluble askarels controlled by dilution or other means to levels consistent with limits established by the appropriate governmental regulatory agency."

In other respects, I favor approval of the revised document, C107.1 (197_).

Sincerely,

Robert D. McClain
NEMA Delegate to ANSI C-107

jg

cc: Mr. C. R. Willmore
NEMA
2101 L Street N.W.
Washington, D.C. 20037

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RD McCLAIN

NEMA

OFFICIAL STANDARDS

PROPOSED AMERICAN NATIONAL STANDARD GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR– AND TRANSFORMER–GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS, C107.1– ( )

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION 155 EAST 44TH STREET, NEW YORK, N. Y. 10017

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PROPOSED AMERICAN NATIONAL STANDARD GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR- AND TRANSFORMER-GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS. C107.1- ( )

(NEMA Official Standards Proposal 1-25-1978.)

This proposal was prepared by NEMA, in cooperation with the Capacitor and Transformer Working Groups of the American National Standards Institute Committee, C107, on Use and Disposal of Hazardous and Toxic Materials.

These proposed standards will be periodically reviewed for any revisions necessary to keep them up to date with developing technology. Proposals or recommended revisions should be submitted to:

Technical Director
Manager, Engineering and Safety Regulations Department
National Electrical Manufacturers Association
155 East 44th Street
New York, New York 10017

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GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR- AND TRANSFORMER-GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 1

PREFACE

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OFFICIAL STANDARDS PROPOSAL

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SECTION I
PREFACE

I. GENERAL

Askarels consisting of or containing polychlorinated biphenyls (PCB's) have been used in many applications for over forty years, but only recently was evidence discovered that PCB's are widely dispersed in the environment. Systematic investigations of the biological effects of PCB's have been undertaken within the past few years to establish the effects of specific formulations upon specific species. Some studies have shown that PCB's may be an environmental contaminant. Simultaneously, significant steps have been taken by U.S. industry to limit further releases of PCB's to the environment.

PCB's have been used in three broad types of applications for the past forty years, as follows: (a) "open ended" applications, for example, in paints, specialty inks, paper coatings, plastics, etc., (b) "nominally closed" applications, for example, as the working fluid in hydraulic or heat transfer systems; and (c) "closed electrical system" applications, specifically as the insulating fluid in certain types of transformers and capacitors. The Monsanto Company is the sole U.S. producer of PCB's. It has discontinued supplying the material for all type (a) and (b) applications.

Evaluations of the alternatives and risk/benefits involved in the continued use of PCB's in closed electrical systems are summarized in the following.

II. BENEFITS

Askarel-filled transformers do not burn or sustain fire under conditions of internal electrical arcing.

Askarel-filled power and industrial capacitors are significantly smaller, more reliable, more durable, and safer than oil-filled capacitors. As a result, askarels have supplanted mineral oils in more than 90 percent of the power and industrial capacitors made today. Over the past few decades most of the equipment that incorporates such capacitors has been designed to take particular advantage of the size, safety and reliability benefits of askarel capacitors (e.g., many types are today less than 1/4 percent of the size of equivalent oil capacitors and have a life expectancy of ten to more than twenty years).

Various federal, state and local codes [illegible] require their continued use in or adjacent to public commercial and industrial buildings which, because present the greatest potential danger to life and property.

III. RISKS

In the United States, medical records over a nearly forty-year period show that the only adverse health effects experienced by U.S. workers exposed to askarels, either during the manufacture of these liquids or of electrical equipment containing these liquids, have been limited to occasional cases of non-chronic chloracne or other temporary skin lesions.

Askarel-filled transformers are [illegible] delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environ-

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ment, transformer failures are limited to approximately 0.02 percent of the units in service per year. With respect to capacitors, such losses are limited to approximately 0.02 percent of the askarel put into service per year. In addition, limited amounts of PCB's can get into the environment during the manufacture, delivery, improper use, maintenance, repair and disposal of transformers and capacitors.

Specific control measures have been instituted by individual manufacturers and are supplemented and strengthened by national standards and procedures such as this Guide which provides information to prevent the inadvertent loss of PCB's to the environment at all stages from initial askarel manufacture through ultimate disposal.

IV. ALTERNATIVES

For technical and local and national code reasons, it would be impossible to replace most askarel-filled transformers now in service with oil-filled units of equivalent ratings, without major construction changes that would be required to compensate for the fire resistance of the askarel-filled units. For certain applications and locations, dry-type transformers may replace askarel-filled transformers.

For new installations, while many of the limitations noted above would still apply, building and installation design provisions could be made to accommodate the use of oil-filled, open dry-type, or sealed dry-type transformers provided necessary technical, code, physical size, and cost considerations are properly evaluated.

The principal alternative to askarels for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1930 level and would necessitate the redesign and replacement of such widely used equipment as fluorescent light fixtures and racks for power and induction heating capacitors, which could not now accommodate the increased size of oil capacitors while maintaining their present ratings.

The cost of askarel liquids is about five to ten times more than mineral oil. Thus, long before there were any environmental concerns about PCB's, there was a strong economic incentive to find other less expensive insulating liquids with the desirable characteristics of askarels. Since the 1930's at least ten major chemical or electrical companies have invested large amounts of time and money in this search with no success. While potential substitutes are not as cost, than askarels have also received some consideration (e.g., fluorinated liquids), little is known about either their electrical performance or possible ill effects upon the environment. There are today no fluids that can be used as a direct replacement for askarels.

V. INTERDEPARTMENTAL TASK FORCE ON PCB'S

An in-depth study of PCB's has recently been completed by five Executive Branch Departments of the federal government. This Interdepartmental Task Force on PCB's issued their report entitled "Polychlorinated Biphenyls and the Environment" on May, 1972.* See section 1 Page 3 for an [illegible] listed on page 4 of this report.

* Distributed by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Price $3.00.

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"The use of PCB's should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCB's in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCB's to all except manufacturers of electrical transformers and capacitors."

Reference should be made to the Interdepartmental Task Force Report for additional information and conclusions.

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GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR- AND TRANSFORMER-GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 2

CAPACITOR GUIDELINES

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SECTION 2
CAPACITOR GUIDELINES

I. INTRODUCTION

The environmental effects of askarels are under in-depth study by governmental and other agencies. Askarels have been considered relatively harmless to humans based on about forty years of safe industrial usage. There has been no known instance of human injury when they were used under the normally accepted precautions and conditions of handling in both manufacturing and user applications.

Traces of askarels are being found in the environment and in fish and wildlife. The long-term genetic and ecological effects are not yet completely understood, but the following rules should be used to contain askarels and minimize their exposure to the environment.

There are two general classes of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their high degree of nonflammability, they are used in transformers where personnel safety is of paramount importance.

Capacitor-grade askarel has a lower degree of chlorination (composed primarily of the 3-chlorine isomers of biphenyl) and a higher degree of biodegradability. Generally, it has not been found in animal life. It is used in capacitors where the extreme degree of nonflammability required in transformers is of less importance.

Although capacitor- and transformer-grade askarels both contain members of the PCB family, they do differ in composition, degree of biodegradability, persistance in nature, electrical stability, chemical stability, and degree of nonflammability. It is recognized as nonflammable. It is for these reasons that this section of the Guidelines is intended to apply to capacitor-grade askarel.

II. CAPACITOR-GRADE ASKAREL

In September of 1971, a new grade of capacitor impregnant, Aroclor 1016, was made available to the industry. This new grade contains a typical concentration of 0.4 percent by weight of the higher boiling homologs of the chlorinated biphenyls. * Aroclor 1016 replaces Aroclor 1242 which previously was the major capacitor impregnant and contained around 7 percent of the higher boiling homologs (the more persistent in nature). This 0.4 percent level of the higher boiling homologs should be the maximum concentration acceptable in any capacitor impregnant. Aroclor 1248 and 1254, previously used as impregnants, do not meet this requirement and should no longer be used in capacitors designed and manufactured for alternating-current applications.

Aroclor 1016 has the same UL nonflammability rating as Aroclor 1242. Its typical properties are given in Table 1. (See section 1 Page 2).

III. PLANT HOUSEKEEPING AND EMPLOYEE SAFETY

The following procedures and limits are intended to be minimum requirements to be met by manufacturers and users of capacitors containing askarel. Handling, control and disposal procedures are given, together with exposure limits and indicated antidotes and cleanup procedures.

A. Material

Askarel for use in capacitors should consist of homologs and isomers of chlorinated biphenyl with the concentration of the higher boiling homologs [illegible] as the standard impregnant meeting these requirements.

* Monsanto Method T-02300.

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Table 1
Typical Properties of Aroclor 1016

Property and Method	Typical Values
Color (APHA)	40, max.
Condition	Clear
Specific Gravity at 25/15.6°C (ASTM D 1810)	1.362-1.372
Acidity (mg. KOH/g.) (ASTM D 974, D 664)	0.010 max.
Moisture	35 ppm. max.
Refractive Index at 25°C (ASTM D 1807)	1.6213-1.6235
Inorganic (Free) Chloride (ASTM D 1222)	0.05 ppm max.
Pour Point (ASTM D 97)	-6°C or lower
Dielectric Constant (ASTM D 924) 1000 Hz at 100°C	4.00-4.30
Resistivity (ASTM D 1169) 100 VDC at 25°C, 6.1-inch	
Edge	10^x x 10^x ohm-cm. min.
Thermal Stability Test (ASTM D 1933) (As Chloride)	3.0 ppm. max.
Thermal Stability Test (ASTM D 1936) (As Chloride)	3.0 ppm. max.
Distillation Range (ASTM D 80 Corrected)	
10 percent Distilled by Weight	323°C. min.
90 percent Distilled by Weight	343°C. max.
Higher Boiling Homologs (Monsanto Method T-20005)	2.0 percent, max.
Sulfates (ASTM D 1275)	None
Dielectric Strength at 25°C (ASTM D 877)	35 KV. min.
Flash Point, Cleveland Open Cup (ASTM D 92)	338°F. min.
Fire Point	None to Boiling Point
Corrosion Test (6 hours at 210°C with bright aluminum foil)	
Change in Weight of Aluminum	0.0 percent
Viscosity at 100°F SUS) (ASTM D 88)	71-81
Specific Heat at 25°C	0.30
Coefficient of Expansion (ASTM D 1903)	0.00068 cc/cc °C
Fixed Chlorine (Carius	41.5 ± 0.5 percent
Power Factor at 100°C 60 Hz (Monsanto Method T-2273)	
Bulk	1 percent, max.
Drums	4 percent, max.

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Commonly used solvents include benzene, kerosene, acetone, trichloroethane, trichloroethylene and perchloroethylene. Typical vapor pressure data for Aroclor 1016 are:

0°C	=	0.001 mm
25°C	=	0.006 mm
150°C	=	4.3 mm
200°C	=	29.0 mm

At 25°C and 760 mm Hg pressure, saturated air contains approximately 0.09 mg/liter.

[1 mg/liter = 90.0 ppm (v/v)]

[1 ppm (v/v) = 0.011 mg/liter]

Bulk Fluid Shipment, Receiving and Transfer

Shipment of askarel from point of manufacture to point of receiving should be done in closed containers such as rail tank cars, truck tanks, marine or barge tanks, or sealed drums. Containers should be labeled as to contents and carry a label cautioning against loss of fluid to the open environment. Containers used to transport askarel should not be used for storage or to transport other material without being completely cleaned of all traces of askarel. (Cleaning procedures must take cognizance of precautions against excessive exposure and of the need for proper disposal of contaminated cleansing solvents and materials as set forth in Part V of this Section.) Transfer from shipping containers to processing systems should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluid lost by leakage or spills from the transfer system [illegible].

Drums to be retired from use should be cleaned before crushing, delivery to scrap dealers, or other disposal. Contaminated cleaning fluids and materials should be disposed of as indicated in Part V.

C. General Safety Precautions

Although it is generally accepted that exposure to capacitor-grade askarel is not hazardous provided simple precautions are taken, exposure should still be avoided.

1. Vapors— The odor of askarel is noticeable well below the maximum air concentrations considered safe. Up to 1.0 milligram per cubic meter of air has been determined to be the maximum safe level of exposure during an 8-hour work day (Par. G, reference 5). The procedures for performing the necessary analyses are contained in Section 6, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls."

Breathing vapors of [illegible] should be avoided. [illegible] made for adequate ventilation and removal of manufacturing operations to avoid open exposure to askarel especially at 150°C or higher. The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride, and small percentages of carbon dioxide, carbon monoxide and oxygen. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarel is necessary under emergency conditions, an approved gas mask or self-contained breathing apparatus should be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of an accident. If the odor of askarel is [illegible] immediately go into fresh air. All gas [illegible] respirators and replacement parts should have Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

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2. Liquid—Unlike insulating oil, there is virtually no fire hazard in handling askarel. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should be such as to minimize or eliminate contact with askarels. Use of eye protection is recommended. The use of porous gloves which can absorb and retain askarels is to be avoided. Barrier creams* or resistant gloves† should be used if contact is unavoidable. Use of enclosed transfer and handling equipment, processing equipment, and mechanical aspects reduces direct contact.

Medicinal washes or mild detergents followed by the application of mild cream will remove the irritation resulting from the contact of an open cut or abrasion with askarel.

Safety glasses with side shields or a face shield should be worn when handling askarels. If liquid askarel contacts the eyes, the eyes should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician. (A drop of castor oil has been found to reduce irritation.)

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under the supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or using toilet facilities.

D. Manufacturing Housekeeping

Manufacturing equipment and operating procedures should safeguard against loss of askarels to the environment through proper containment and disposal procedures.

Enclosed systems of tanks, piping, properly gas-ketted joints, valves, containers and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 55°C. Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all askarel processing areas to ensure against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

Spills of askarel should be removed promptly by means of absorptive material, such as sawdust, or trapped and removed by pumping or other suitable means.

---

* For example, PLV No. 9 Gel (Milburn Co., Detroit, Michigan), or Herodex #71 (Ayers Laboratories, P. O. Box 236, Church Street Station, New York, N.Y. 10049), or the equivalent.

† Edmont, Solvit 5-Mil (Merrick of Bridgeport, 22 Cross Street, Bridgeport, Conn. 06601), or the equivalent.

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Waste fluids containing askarel not suitable for reconditioning or reuse should be collected (by means of traps, drip pans, trays, etc.) from the various parts of the manufacturing and processing area (including washers or other cleaning devices). Disposal should be made in accordance with Part V of this section.

Wiper rags, clothing and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled laundering or disposal (see Part V of this section).

E. Disposal of Askarel Wastes

Methods for disposal of liquids and saturated [illegible] generated by the manufacturing operation should be in accordance with those published in Part V of this section and should include but not be limited to the following wastes:

1. Contaminated liquid askarel which is unsuitable for reconditioning as a dielectric fluid.
2. Liquid askarel from solvent operations or water/detergent type washers.
3. Saturated earth or other absorbent media from filtering operations.
4. Saturated sawdust or other absorptive materials from spills.
5. Saturated filters from vapor control devices and other filters.
6. Saturated wastes (paper, rags, etc.).
7. Saturated spent [illegible]
8. Askarel-contaminated vacuum pump oils.
9. Askarel-contaminated steam jet vacuum system condensates.

F. Miscellaneous Procedures

1. Spills by leakage from finished capacitors should be cleaned up promptly by means of absorbent media which should then be moved to containers provided for that purpose within the containment area and later disposed of properly.
2. Askarel wastes should never be disposed of down effluent drains or sewers. The utmost care must be exercised to prevent accidental loss by these avenues to the environment.
3. Capacitors failing tests or otherwise designated for disposal must be controlled and handled in accordance with the intent of the procedures above, finally being disposed of by one of the methods outlined in Part V of this section.

G. References

1. Monsanto Industrial Chemicals Company, Technical Bulletin No. 12, Aroclor® Poly Chlorinated Polyphenyls Exclusively (November 1971).
2. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. AMA Archieves of Environmental Health 9:545 (1964).
3. Treon, J.F., F.P. Cleveland, J. Cappel, and R.W. Atchley: The Toxicity of the Vapors of Aroclor 1248 and Aroclor 12[illegible]. American Industrial Hygiene Association Quarterly [illegible].
4. Elkins, H.B.: The Chemistry of Industrial Toxicology. John Wiley and Sons, Inc., New York (1959).

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5. Drinker, C.K., M.F. Warren, and G.A. Bennett: The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology 19:283 (1937).

6. Drinker, C.K.: Further Observations on the Possible Systemic Toxicity of Certain of the Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology 21:155 (1939).

7. Greenburg, L., M.R. Mayers, and A.R. Smith: The Systemic Effects Resulting from Exposure to Certain Chlorinated Hydrocarbons. Journal of Industrial Hygiene and Toxicology [illegible].

8. Hygienic Guide Series "Chlorodiphenyls" (January-February 1965) by the American Industrial Hygiene Association, 210 Haddon Avenue, Haddonfield, N.J. 08033.

IV. CONTROL OF WATER EFFLUENTS

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems in capacitor manufacturing plants are probably contaminated as a result of past practices, and askarel traces may continue to show up in effluent streams for some time. However, the level should continue to [illegible] with the proper containment of askarel [illegible] and no direct discharges into drain systems. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams and that accidental spills be prevented from getting into such streams.

A. Concentration Limits

The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.

B. Monitoring Streams

On a regular basis consistent with plant situations, all effluent streams should be analyzed. The procedures for performing the necessary analyses are contained in Section 3, Analysis of Water and Sediment for Polychlorinated Biphenyls. This procedure or its equivalent should be used.

C. Methods for Minimizing Effluent Stream Contamination

The ideal approach is to totally isolate all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant. Carbon adsorption, limestone beds, and solvent extraction are techniques which can be applied to reduce the askarel content of effluent streams. These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

V. SCRAP DISPOSAL PROCEDURES

The manufacture and [illegible] of capacitors [illegible] and [illegible] containing [illegible] askarel, which should be disposed of as wastes. Specific sources of these materials appear throughout this document but may be placed into three categories:

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1. Capacitor units impregnated with askarel, production and field rejects.

2. Manufacturing process liquid wastes containing askarel.

3. Solid waste purposely or accidently saturated with askarel.

Disposal should be done in a manner which is consistent with proper concern for the environment and which minimizes any release of askarels to the environment.

[illegible] Disposal of Capacitor Units

Scrap capacitor units can be [illegible] the manufacturing processes in which they were used.

Production rejects are those capacitors which are rejected after the impregnation process in the course of production by the capacitor manufacturer. They may be rejected for mechanical or electrical reasons, or because of noncompliance.

Field rejects are those units which are rejected or which, for other reasons, are to be scrapped after shipment from the plant where they were manufactured.

1. Production Rejects—Rejected capacitors in capacitor manufacturing plants represent a concentration of askarel. It is important that their disposition be made in a manner consistent with proper concern for the environment. Therefore, capacitors should be disposed [illegible] requirement.

   Care should be exercised to insure that no loss of liquid will occur during transportation to the disposal site.

   Incineration of scrap capacitors in facilities designed to accept such solids should provide an alternative means of disposal as such services become available in the future.

2. Field Rejects—Small capacitors (defined as containing less than 3 pounds of askarel) are practically always used as components in other electrical or electromechanical equipment. Typical examples of large quantity usage of such capacitors are in fluorescent lamp ballasts and residential air conditioning equipment. Failure of such capacitors may result in scrapping of the device of which it is a part (as in a fluorescent ballast) or replacement and scrapping of the individual capacitor (as in a room air conditioner). However, the majority of such capacitors are [illegible] in service but are scrapped as a result of wearing out of the [illegible] of service in which the capacitors are used as components. Thus, the matter of disposal is characterized by a low concentration of small quantities of askarel throughout the country and, indeed, throughout the world. Ultimately, the nature of the devices and equipment in which such capacitors are used is such that they are normally disposed of in dry landfills as a matter of convenience. Since it is impractical at present to exercise any meaningful control over the disposition of the bulk of such devices and equipment, it is imperative that askarel used for impregnating small capacitors be limited to the recently introduced type which contains a typical concentration of 0.4 percent of the higher boiling homologs.*

   Large capacitors (those incorporating [illegible] pounds of askarel) [illegible] of the industry to the [illegible] (see Sec. [illegible]).

* Monsanto Method T-02002.

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B. *Disposal of Liquid Wastes*

All waste askarel or liquid wastes containing askarel should be disposed of in accordance with one of the following procedures:

1. Incineration—Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability and, finally, suitable scrubbers to remove the HCl which will be formed; e.g., (1) 2-second dwell time at 2000°F and 3 percent excess oxygen in stack gas; (2) 1 1.2-second dwell time at 2700°F and 2 percent excess oxygen in stack gas.

   These facilities should meet the applicable requirements of the State in which they are located and should control effluents within the limits set forth in this document.

2. Toxic and Hazardous Waste Disposal Sites—Certain landfill sites have been classified by State and Federal Governments as suitable for the disposal of toxic and hazardous liquids. Where such approved sites exist, they may be used for the disposal of liquid wastes described in this document. (See Section 4.)

3. Packaging and Shipment—

   a. Transportation to the disposal facility should be in containers which will prevent leakage of askarel to the environment.

   b. Containers should be labeled as to contents and precautions relative to loss to the environment.

   c. Containers used for this purpose should not be used for any other materials or retired from service until they are completely cleaned. Any solvents used in cleaning these containers will be contaminated with askarel and should be disposed of according to the same procedures herein described.

C. Disposal of Solid Wastes
(See Par. A for Scrap Capacitors)

All solid wastes which have been saturated with askarel should be disposed of by the following procedure:

1. The saturated wastes may be placed into leak-proof containers and taken to a supervised dry landfill site. Transport to disposal site should be in closed containers. Alternatively, incineration can be used in accordance with par. B (See Section 4 for facilities).

VI. LABELING

Capacitor units vary greatly in size and in end use or application. Small capacitor units are normally supplied as a component of another piece of equipment such as a fluorescent lighting fixture, a room air conditioner, or a television set. In such applications a label on the capacitor unit referencing approved disposal procedures will not normally be visible when the piece of equipment is disposed of.

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For the foregoing reasons the method of providing disposal instructions for small capacitors and large capacitors is treated separately.

1. Small Units (Incorporating Less Than 2 Pounds of Askarel)—Small capacitors are defined as those which contain askarel in quantities up to about two (2) pounds each and in which the free liquid does not exceed 0.4 pound. They are hermetically sealed in metallic cases. Such capacitors are applied as a component of a larger piece of equipment. Attaching a label to such equipment referencing this Guideline or describing disposal procedures would be of limited practical value.

2. Large Capacitor Units (Incorporating More Than 2 Pounds of Askarel)—The capacitor manufacturer shall affix a label in a conspicuous place, referencing this document or describing disposal procedures consistent with it. This label should contain, as a minimum, the following information:

CAUTION

THIS CAPACITOR CONTAINS A POLYCHLORINATED BIPHENYL (PCB). TO AVOID POSSIBLE ENVIRONMENTAL CONTAMINATION, IT SHOULD BE DISPOSED OF ONLY IN SUPERVISED DRY LANDFILL AREAS MEETING STATE REQUIREMENTS OR IN INCINERATION FACILITIES DESIGNED FOR DISPOSAL OF PCB'S.

SEE AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINES [illegible] FOR FURTHER INFORMATION. COPIES MAY BE OBTAINED FROM ANSI, 1430 BROADWAY, NEW YORK [illegible].

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GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR- AND TRANSFORMER-GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 5

TRANSFORMER GUIDELINES

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SECTION 3
TRANSFORMER GUIDELINES

I. GENERAL GUIDELINES

A. Definitions—Types of Transformer Askarels

The term askarel generally describes a broad class of nonflammable synthetic chlorinated hydrocarbon insulating liquids widely used in transformers, reactors, and accessory equipment operated at power frequencies. Askarels of various compositional types are in use [for the general properties and types, see ASTM Specification for Chlorinated Aromatic Hydrocarbons (Askarels) for Transformers, D 2288]. Under arcing conditions the gases produced, while consisting of predominantly noncombustible hydrogen chloride, can [illegible] amounts of combustible gases depending [illegible] type.

The following trade names are [illegible] manufacturers to designate askarels used in their products.

Aroclor
Chlorextol
Inerteen
No-Flamol
Pyranol
Saf-T-Kuhl

B. Safety Precautions

Based on about forty years of safe industrial usage, askarels have been considered as relatively harmless materials to humans. There has been no known instance of [illegible] when askarels are used under the normally [illegible] conditions of [illegible].

Although it has been [illegible] thought that exposure to askarels is not hazardous provided simple precautions are taken, exposure should still be avoided and minimized.

1. Vapors—The odor of askarel is noticeable well below the maximum safe air concentrations. Depending upon the composition of the askarel used, from 0.5 to 1.0 milligram per cubic meter of air has been determined to be the upper safe level of exposure during an 8-hour work day. (See American Industrial Hygiene Association Hygienic Guide Series—January/February, 1968.) The procedures for performing the necessary analyses are contained in Section 5, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls." This procedure or its equivalent shall be used.

Breathing vapor or fumes from [illegible] should be avoided. High or [illegible] of vapors can cause irritation of the eyes, nose, throat and upper respiratory tract. Provisions shall be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure of hot askarels (65°C or higher). The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride, and small percentages of other gases. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarels or its arc-by-products is necessary under emergency conditions, an approved [illegible] type of [illegible] must be worn. Such exposure should be under the surveillance of other persons, capable of rescue in case of accident. If the odor of askarel or its arc-by-products is detected by the person wearing protective

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1. Storage Tanks—Storage tanks should be erected so that inspection can be made for leaks or spills. Construction should be such that inadvertent leakage or spills are prevented from reaching streams and sanitary or storm sewers.

2. Tank Cars and Tank Trucks—All bulk shipment equipment should be inspected for leaks immediately upon receipt. Drain pans must be provided to prevent spillage from unloading hoses and connections. Askarel liquid collected in drain pans should be placed in "SCRAP ASKAREL" drums for disposition.

3. Steel Drums, Cans, and Test Sample Containers—On delivery, all such shipments should be carefully inspected for leaks. The containers should be stored indoors in an area especially selected for this purpose. A curb should enclose the area to provide a basin for containing the askarel from one or more containers should the containers be damaged. The area must not have a drain which is connected to a sanitary or storm sewer.

   If an indoor storage area is not possible, the containers should be stored under a lean-to.

E. Water Effluents—Sampling, Concentration Limits and Analytical Procedures

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems from manufacturing plants, apparatus and installations may be contaminated as a result of past practices. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams and that accidental spills be prevented from getting into such streams.

1. Concentration Limits—The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.

2. Monitoring Streams—All plant effluent streams should be monitored on a regular basis, consistent with plant situations. The procedures for performing the necessary analyses are contained in Section 5, "Analysis of Water and Sediment for Polychlorinated Biphenyls." This procedure or its equivalent shall be used.

3. Methods for Minimizing Effluent Stream Contamination—The ideal approach is to totally isolate all effluent streams that could be contaminated with askarel during maintenance processes that prevent them from being discharged from the plant.

F. Disposal Procedures and Services

1. Sources of Materials Requiring Special Handling and Disposal Procedures—Liquids containing PCB's and solids containing or contaminated with PCB's may be obtained from any of the following sources: transport containers, transformer manufacturing processes, in-test failures, liquids contaminated beyond reclamation, in-service transformer leaks and failures, askarel-filled transformers scrapped for any reason, etc.

2. [illegible] Commercial Disposal Services—In general, the three types of materials requiring disposal: liquids, burnable solids, materials containing PCB's and nonburnable solid materials contaminated with PCB's.

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equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

2. Liquid—Unlike mineral insulating oil, there is no fire hazard in handling askarels. A limited solvent action similar to that for paint thinners on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to tissue.

Operating procedures should require avoidance of contact with any askarels. The use of porous gloves which can absorb and retain askarels is to be avoided. Resistant gloves and aprons of the neoprene, polyethylene, viton type should be used if contact is unavoidable. In case of spillage on the clothing, the clothing should be removed as soon as practical, the skin washed and the clothing laundered.

Medicinal washes or mild detergents followed by the application of cold cream will reduce the irritation resulting from the contact of an open cut or abrasion with askarel.

Safety glasses with side shields or face shield should be worn when handling askarels. Eyes which have been exposed to askarel should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician if the irritation persists. A drop of castor oil has been found to reduce irritation.

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or using toilet facilities.

C. Transport Container Marking

Any container such as tank cars, tank trucks, drums, cans, etc., used to transport transformer askarels, new or used, should be labeled with the following:

CAUTION

THIS PRODUCT CONTAINS POLYCHLORINATED BIPHENYLS (PCB'S). CARE SHOULD BE TAKEN TO PREVENT ENTRY INTO THE ENVIRONMENT THROUGH SPILLS, LEAKAGE, USE, VAPORIZATION, OR DISPOSAL OF LIQUID OR CONTAINERS. AVOID PROLONGED BREATHING OF VAPORS OR MISTS. AVOID CONTACT WITH EYES OR PROLONGED CONTACT WITH SKIN. IF SKIN CONTACT OCCURS, REMOVE BY WASHING WITH SOAP AND WATER. FOLLOWING EYE CONTACT, FLUSH WITH WATER. IN CASE OF SPILLAGE ONTO CLOTHING, THE CLOTHING SHOULD BE REMOVED AS SOON AS PRACTICAL, SKIN WASHED, AND CLOTHING LAUNDERED.

D. Receiving Inspection

Askarels are shipped in tank cars, tank trucks, steel drums, metal cans and test sample containers. When received, all containers should be inspected for leaks.

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a. Liquids. Liquids containing PCB's requiring disposal by high-temperature incineration may consist of the following:

(1) PCB's contaminated with mineral oil.

(2) Mineral oil contaminated with PCB's.

(3) Nonreclaimable contaminated transformer askarels, arced askarels, askarels from manufacturing spills, and sump accumulation, etc., rich in PCB's, and askarels from holding basins, drip and drain pans, washings, sample jars and containers, etc.

b. Burnable Solid Waste Material Containing PCB's. These materials can be disposed of by high-temperature incineration and consist of cellulosic materials, rags, pressboard, wood, sawdust, fuller's earth in bulk or in cloth bags, blotter papers, rubber or cork gaskets, etc.

c. Nonburnable Solid Waste Materials Containing or Contaminated with PCB's. These materials may consist of coil structures, steel, copper, aluminum filter units of the steel mesh construction type, askarel drums, cans, etc.

Materials of this nature will be allowed to drain with the liquid collected in drip pans, etc. Further removal of adhering PCB's can be accomplished by washing or solvent extraction with kerosene or other approved washing liquids such as perchloroethylene or trichloroethylene. Accumulated liquids can be disposed of as indicated in par. F.3.a. Solid materials may be handled as normal scrap.

3. Shipment of Scrap Liquids for Disposal—All liquid scrap material should be placed in appropriate metal transport drums, properly labeled, for shipment to a company offering an acceptable disposal service.

4. Shipment of Burnable Solid Waste Material Containing PCB's for Disposal—Material of this type should be placed in open head drums with suitable closures and with the drum properly labeled for shipment to a company offering an acceptable disposal service.

5. Liquid and Solid Waste Disposal Service Organizations—

a. General. Disposal of askarels and askarel-soaked materials should be accomplished by means in which there is no significant release of askarel to the environment. At present, disposal is accomplished by carefully-controlled incineration of liquids and soaked refuse, and by controlled landfill burial of apparatus and other hardware from which askarel has been previously drained and washed.

Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability. [illegible] by [illegible] at 2000°F and 3 percent excess oxygen in stack gas; (2) 1 s 2-second dwell time at 2700°F and 3 percent excess oxygen in stack gas.

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These facilities should meet the applicable requirements of the State in which they are located and should control effluents within the limits set forth in this document.

Controlled landfill or deep-well disposal can be used where permitted by Federal, State and local regulations.

b. Costs. In addition to the normal costs of collecting scrap liquids and solids for disposal, additional costs borne by the owner of such scrap include shipping containers, cost of transport to the disposal service organization, and a disposal fee usually based upon a per gallon or per pound charge.

c. Disposal Services. Organizations offering disposal services are listed in Section 4, including their location, facilities available, types of material handled, and disposal procedures used. Specific shipping directions, disposal procedures and costs should be obtained from the organization.

II. SPECIFIC GUIDELINES

A. Transformer Manufacturers, Service Shops, etc.—Housekeeping

It is necessary to assume that in filling equipment with askarel and during further handling of this equipment an askarel spill may occur. Therefore, it is necessary to provide facilities and a procedure for clean-up to prevent contamination.

1. Askarel Filling Area—

a. The location of the askarel filling area should be adjacent to the test area and final shipping area to minimize the danger of damage of units during handling.

b. The main manufacturing area for filling equipment with askarel should be provided with impervious surface floors or suitable basins so constructed that any inadvertent leakage or spills are prevented from reaching streams, sanitary, or storm sewers. All askarel-handling equipment such as pumps, hoses, etc., shall be of the askarel-resistant type.

c. Drip pans shall be provided for hose connections and filling valves.

2. Special Containers for Scrap Materials—

a. Drums labeled "SCRAP ASKAREL" should be available for handling all spilled and waste askarel from pumps, filled units, drip pans, sample jars, etc.

b. Open-head drums with suitable closures and labeled "SCRAP BURNABLE ASKAREL WASTE" should be available for handling contaminated cellulose insulation, rags, paper pressboard, wood, gaskets, sawdust, etc.

c. Separate containers for handling steel, copper, and aluminum, each adequately marked, shall be provided for the components of contaminated core and coil assemblies. These containers are required for the same material when repairing or scrapping askarel units.

d. Containers for supplies of material for absorbing small askarel spills or clean-up of larger spills should be provided.

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3. Conditioning of Askarels—

a. Askarel Conditioning Equipment. The conditioning unit should be located either in the storage tank area or the main transformer manufacturing area for filling with askarel.

b. Fuller's Earth. Conditioning of new askarel or recycled askarel requires fuller's earth treatment. The spent fuller's earth in cartridges or bags, when replaced, should be allowed to thoroughly drain over drip pans to remove as much liquid askarel as possible. The cartridge cage of steel mesh construction should be placed in the "STEEL CONTAMINATED WITH ASKAREL" container for disposition. Cloth bags filled with fuller's earth should be placed in the "SCRAP BAG LIKE ASKAREL WASTE" container for disposition.

4. Teardown of Units for Repair or Scrap—

a. Drain all askarel from the unit either into a holding tank for reuse or into the drum labeled "SCRAP ASKAREL" for disposition, and then allow sufficient time for all of the askarel to drain from the core and coils.

b. Remove the core and coil assembly from the transformer. Sufficient absorbent material should be placed on the floor to absorb any askarel fluid that spill drips from the transformer.

c. Place all materials in the appropriate salvage items, [illegible] marking to [illegible]

d. All used materials, including rags, sawdust, tape, etc., regardless of quantity, shall be put into the appropriate containers for disposition.

B. Transformer Labeling

1. New Transformers—All new transformers that contain PCB's shall have a label of adequate durability permanently and prominently attached to the tank by the manufacturer, giving adequate warning and instructions. A suggested label includes the following:

CAUTION

THE INSULATING LIQUID IN THIS TRANSFORMER CONTAINS POLYCHLORINATED BIPHENYLS (PCB'S). CARE SHOULD BE TAKEN TO PREVENT ENTRY INTO THE ENVIRONMENT. IN CASE OF MALFUNCTION OR LEAKS, CONSULT THE INSTRUCTION MANUAL OF THE MANUFACTURER.

2. In-service Transformers—The transformer manufacturer should make available suitable labels with a similar warning as shown in par. B.1 for use on existing transformers.

C. Transformer Users—Shipping, Installation, Maintenance, Sampling, Apparatus Disposal

1. General—Askarel-filled transformers are delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environment, such cases are [illegible]

2. Transportation and Receiving—Immediately upon receipt of the equipment and following any transportation or handling accident which could affect the integrity of the tank, inspe-

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ings or radiators, the transportation vehicle, tank and fittings should be examined for any leakage or spillage that may have occurred in shipping. If leakage is evident, the cause should be corrected and the spillage soaked up with absorbent materials such as sawdust, followed by a clean-up of the affected area with rags soaked with kerosene or other approved solvent such as perchloroethylene or trichloroethylene. All materials used should be collected for proper disposition as described in Section 3 Part 1, par. F, "Disposal Procedures and Services."

3. Installation and Periodic Inspection—Following installation, the unit should again be inspected for any damage or leakage. It is recommended that periodic maintenance inspections be made for any leaks.

4. Filling, Filtering, or Drying Askarel—Most askarel units are shipped with the proper amount of askarel but if it becomes necessary to top off a unit, the manufacturer's instructions should be followed.

If it is necessary to dry or fuller's-earth-treat an askarel unit, the manufacturer's instructions should be followed. When filtering or conditioning askarel, all of the precautions previously described for ship pans, proper disposal of filter media, etc., apply.

5. Sampling—It is common practice to sample askarel from a transformer for periodic maintenance testing. As previously described, such samples should be taken in a manner to avoid any contamination of the environment. Washings should be collected for proper disposal. Field and laboratory test sample washings, etc., should also be collected for proper disposal.

6. Transformer Disposal—The ultimate disposal of an askarel-filled transformer may be accomplished in either of two ways

   a. Complete drainage and dismantling with the proper disposal of the askarel and askarel-wetted components as described earlier in Section 3, Part 1, par. F, "Disposal Procedures and Services."

   b. Disposition of askarel transformers by means of junk or scrap dealers should be avoided unless a transformer is first drained, followed by soaking the interior with a suitable solvent. Accumulated liquids and washings are to be disposed of as described earlier.

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GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR- AND TRANSFORMER-GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 4

DISPOSAL SERVICES

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SECTION 4
DISPOSAL SERVICES

In addition to the supervised dry landfill sites which may be used for the disposal of askarel-containing scrap, the following additional known facilities and services have been established, and others may be available.

Chem-Trol Pollution Services, Inc.,
4818 Lake Avenue
Blasdell, New York 14219
Phone 716-826-3850

This organization has facilities and services capable of handling:

1. Liquids—Askarels alone or mixed with solvents or oils. Disposal is by high-temperature incineration.

2. Solids (Software)—Askarel-soaked compounds, rags, papers, absorbing materials, etc. Disposal by incineration or scientific landfill.

3. Solids (Hardware)—Capacitors, transformer tanks, cores, askarel-soaked metals. Disposal by scientific landfill. Has solvent extraction capability.

Monsanto Company
800 No. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone 314-694-1000

This organization has facilities and services capable of handling askarel liquids alone or mixed with other oils or solvents by high-temperature incineration. Waste is pumped through a gun with atomizing steam into combustion. Temperatures are maintained at 2000-2500°F with auxiliary natural gas. Exit gases are quenched to 250°F by contact with water. Gas is then passed through a high-energy, venturi scrubber for removal of particulates. Before exhausting to air (110°F), gases are passed through a packed column scrubber to remove HCl.

Nuclear Engineering Company

Eastern Division
P. O. Box 140
Morehead, Kentucky 40351
Phone 606-784-6611

Disposal Division
Sheffield, Illinois
Phone 815-454-2324

This organization provides complete transportation and disposal services for all liquids and solids (including hardware). Disposal is in controlled chemical and scientific landfill area. AEC licensed for radioactive waste disposal. Has two West Coast locations in states of Washington and California in addition to above.

Rollins-Purle, Inc.
Box 3340
Wilmington, Delaware 19807
Phone 302-475-8160

This organization has facilities and services capable of handling.

1. Liquids—Askarel alone or mixed with solvents or oils. Disposal is by high-temperature incineration.

2. Solids (Software)—Askarel-soaked [illegible] compounds, rags, papers, absorbing materials, etc. Disposal is by incineration at high combustion temperatures up to 2500°F. The incineration gases are scrubbed and entrained solids removed before exhausting to air.

NPC00007407

OFFICIAL STANDARDS PROPOSAL

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Disposal facilities are available at the following locations:

Logan:	Rollins-Purle, Inc. Route 322 Logan Township Bridgeport, New Jersey 08014
Baton Rouge	Rollins-Purle, Inc. Scenic Highway & W. Cheatham Lane Scotlandville East Baton Rouge Parish Louisiana 70807
Houston:	Rollins-Purle, I. . Tidal Road & Highway 134 Deer Park, Texas 77536

NPC00007408

770047

GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR- AND TRANSFORMER-GRADE ASKAREL CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 5

APPENDIX

ANALYTICAL PROCEDURES AND LABORATORY SERVICE ORGANIZATIONS

NPC00007409

OFFICIAL STANDARDS PROPOSAL

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SECTION 5
APPENDIX

ANALYTICAL PROCEDURES AND LABORATORY SERVICE ORGANIZATIONS

Analytical procedures for determining PCB's in air, water, and sediments are given in Parts I and II of Section 5.

The following laboratories are representative of those offering services for PCB analyses:

Carus Chemical Corp.
1375 Eighth Street
LaSalle, Illinois 61301
Phone 815-223-1500

[illegible], Inc. (Subsidiary of Carus Corp.)
[illegible] East Pond du Lac Avenue
[illegible], Wisconsin [illegible]
Phone 414-[illegible]

Galson Analytical Service Corp.
41 Industrial Road
Berkeley Heights, New Jersey 07922
Phone 201-464-2551

I. A TENTATIVE PROCEDURE FOR THE DETERMINATION OF AIRBORNE-POLYCHLORINATED BIPHENYLS

A. Scope

This procedure is based on techniques used by the Monsanto Industrial Chemical Company for the isolation and determination of polychlorinated biphenyls (PCB's) in water, sediment, and biological materials.

Absolute confirmation of PCB structures is not obtained with this method. Where needed, additional structure proof should be obtained using techniques such as mass spectrometry to further identify GC fractions.

B. Principle

Airborne PCB's are absorbed in toluene by drawing the air through one or more impinger bubblers or impingers in cylinders filled with toluene. After sampling, a suitable aliquot of the absorbing solvent is diluted as necessary and interfering components, if present, are removed by chemical treatment and column absorption chromatography. The amount and type of PCB's present is determined by electron capture gas chromatography (ECGC).

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C. Reagents

Hexane	Nanograde, Mallinckrodt Chemical Works, Catalog No. 4139.
Toluene	Nanograde, Mallinckrodt Chemical Works, Catalog No. 8092.
Sodium sulfate	Anhydrous, granular: AR grade. Mallinckrodt Chemical Works, Catalog No. 8042. Heat at 400°C for 1 hour prior to use.
Alumina adsorption	(For chromatographic analysis) 80-200 mesh, Fisher Scientific Company, Catalog No. A540. Heat at 400°C for a minimum period of 4 hours and deactivate with 5% (w/w) distilled water.
	Alumina column preparation: Fill a chromatographic column with hexane up to the point where the reservoir joins the column and place a glass wool plug in the column with a glass rod. In a 50 ml. beaker mix 5 g. of the deactivated alumina (ca. 80g), and pour this slowly into the column. Tap or vibrate the column to settle the alumina and top the alumina with 2-3 cm of anhydrous sodium sulfate. Wash the column with 50-100 ml of hexane prior to the addition of the sample.
Distilled water	Extracted with hexane to remove hexane soluble electron capturing impurities.
Sulfuric acid	Analytical Reagent Grade, SG = 1.84.
Potassium hydroxide	Analytical Reagent Grade.
Ethanol	Formula 2B.
2.5% (w/v) alcoholic potassium hydroxide	Dissolve 70 to 12.5 grams of AR grade KOH in 500 ml of ethanol.
3/1 (v/v) sulfuric acid	(Carefully add 250 ml. of AR grade [illegible] to 100 ml. of distilled water [illegible] beaker.
PCB Standards	Aroclor 1016, 1221, 1242, 1248, 1254 and 1260. See [illegible] (pages 17 to 19).

NPC00007411

OFFICIAL STANDARDS PROPOSAL

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D. Apparatus

1. Gas scrubbing bottles, high form, ground glass joint, fritted coarse discs.

2. Separatory funnels equipped with ground glass stoppers and Teflon stopcocks: 125, 250, 500, 1000 and 2000 ml capacities.

3. Kunderna-Danish evaporative concentrators, 500 ml capacity equipped with 3-ball Snyder columns and graduated 5 ml capacity vials; Ace Glassware Company, Catalog No. 6707.

4. Chromatographic columns, glass, 10" x 20 mm (OD) with a 5" x 20 mm (OD) reservoir at the top, equipped with Teflon stopcocks.

5. Flat-bottomed boiling flasks, 125 ml capacity; Ace Glassware Company, Catalog No. 6300, Cone - 24.

6. Liebig condenser, 200 mm in length; Ace Glassware Company, Catalog No. 6913, Cone - 18.

7. Hot plates, Corning PC-100; Fisher Scientific Company.

8. Water bath, Thelco, Precision Scientific, Model No. 84, Fisher Scientific Company.

9. 10 µl Hamilton syringes, Catalog No. 701N.

10. Dry test meter or wet test gas meter.

11. Laboratory vacuum pump.

12. Rotating vacuum evaporator.

13. Usual laboratory glassware.

E. Sampling (See Fig. 5-1.)

The air to be sampled for [illegible] is drawn through a gas scrubber [illegible] and a dry test meter using a laboratory vacuum pump. The sampling flow rate is controlled by bleeding in air via a needle valve located between the pump and the meter. At the end of the sampling period, the metered gas volumes are corrected for temperature and pressure to cubic meters at 25°C and 760 mm Hg.

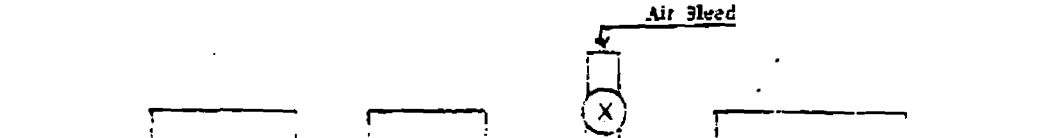


Fig. 5-1
SAMPLING TRAIN

NPC00007412

Fig.

NPC00007427

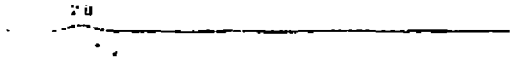
770066

AROCLOR 1221

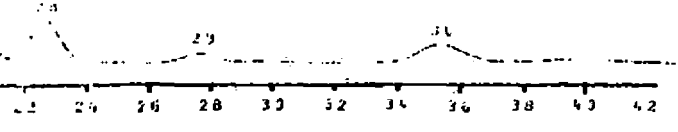
AROCLOR 1242

AROCLOR 1248

AROCLOR 1254



AROCLOR 1260



AROCLOR 1221

H&P 402 Ni-63 EC
1/4" x 6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 170°C
Inj Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH_4/Argon 120 ml/min.
Pulse Interval - 50 μsec
Amt. Injected - 5 μl
Std. Conc. - 1.48×10^{-6} g/ml
Range - 10
Attn. - 4

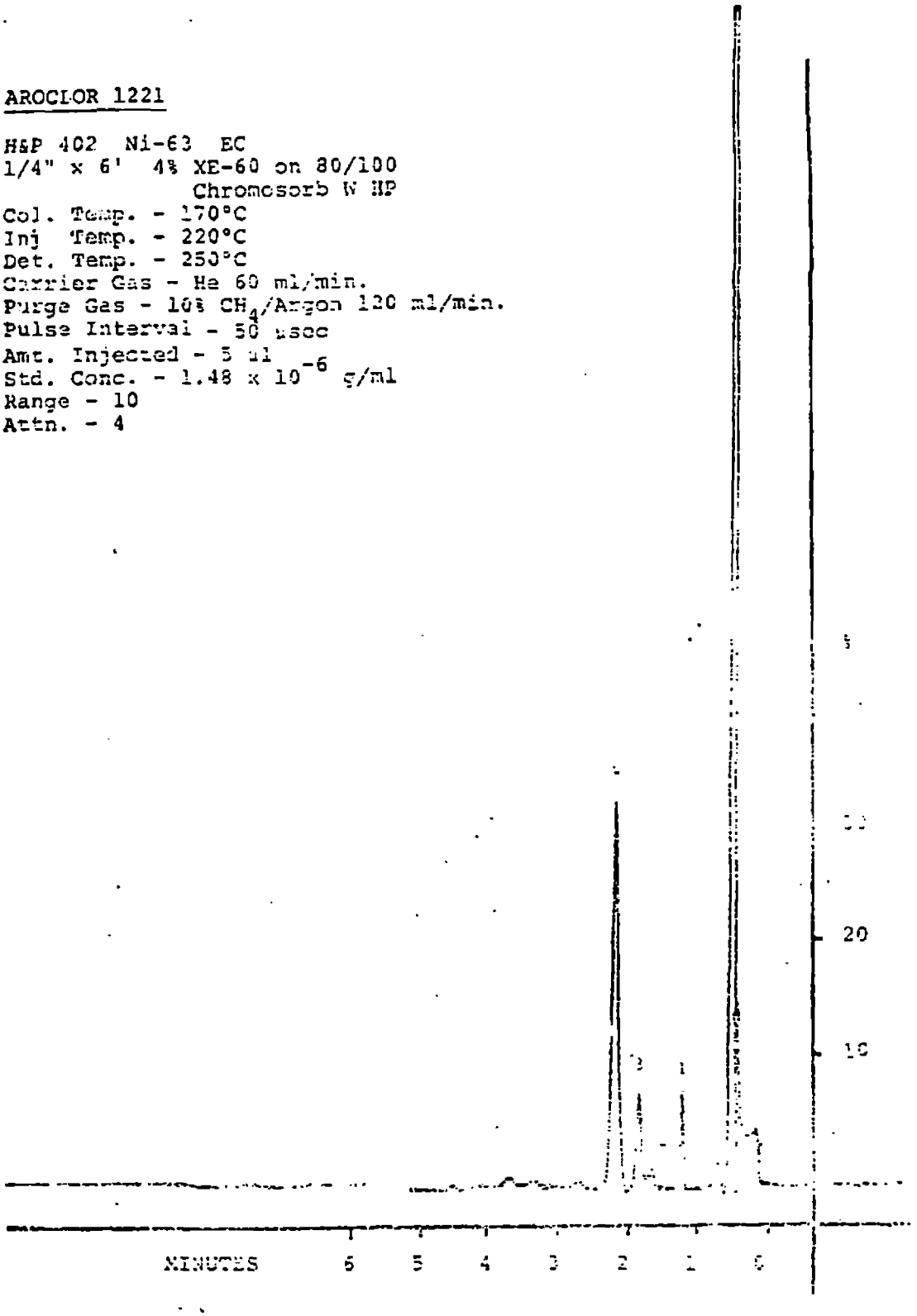


Fig. 6-1

NPC00007428

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AROCLOR 1242

H&P 402 Ni-63 EC
1/4" x 6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 190°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH_4/Argon 120 ml/min.
Pulse Interval - 50 usec
Amt. Injected - 5 µl
Std. Conc. - 1.03 x 10^{-6} g/ml
Range - 10
Attn. - 8

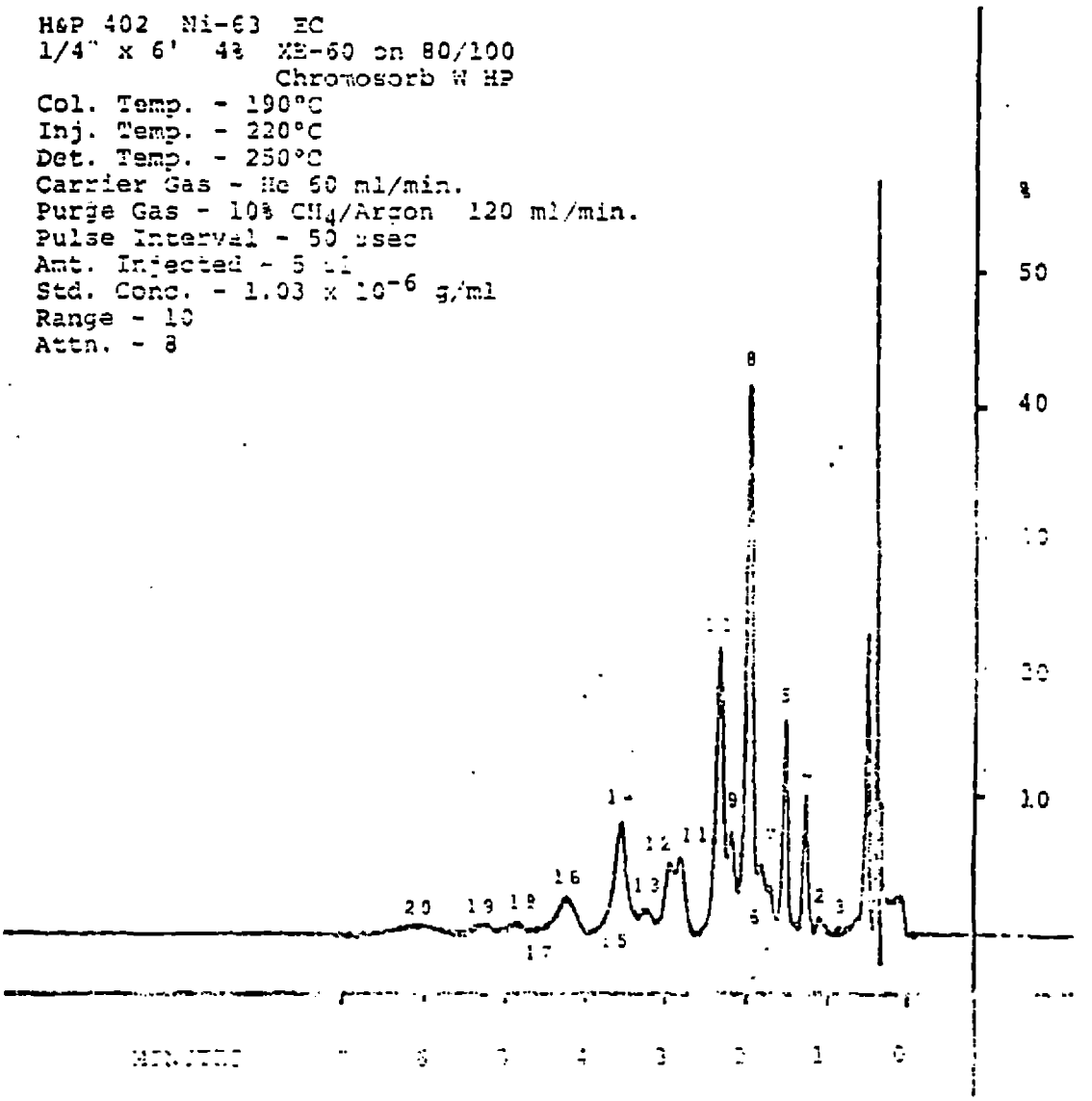


Fig. 5-6

NPC00007429

770068

AROCLOR 1248

H&P 402 Ni-63 EC
1/4" x 6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 190°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH_4/Argon 120 ml/min.
Pulse Interval - 50 usec
Amt. Injected - 5 µl
Std. Conc. - 1.31×10^{-6} g/ml
Range - 10
Attn. - 4

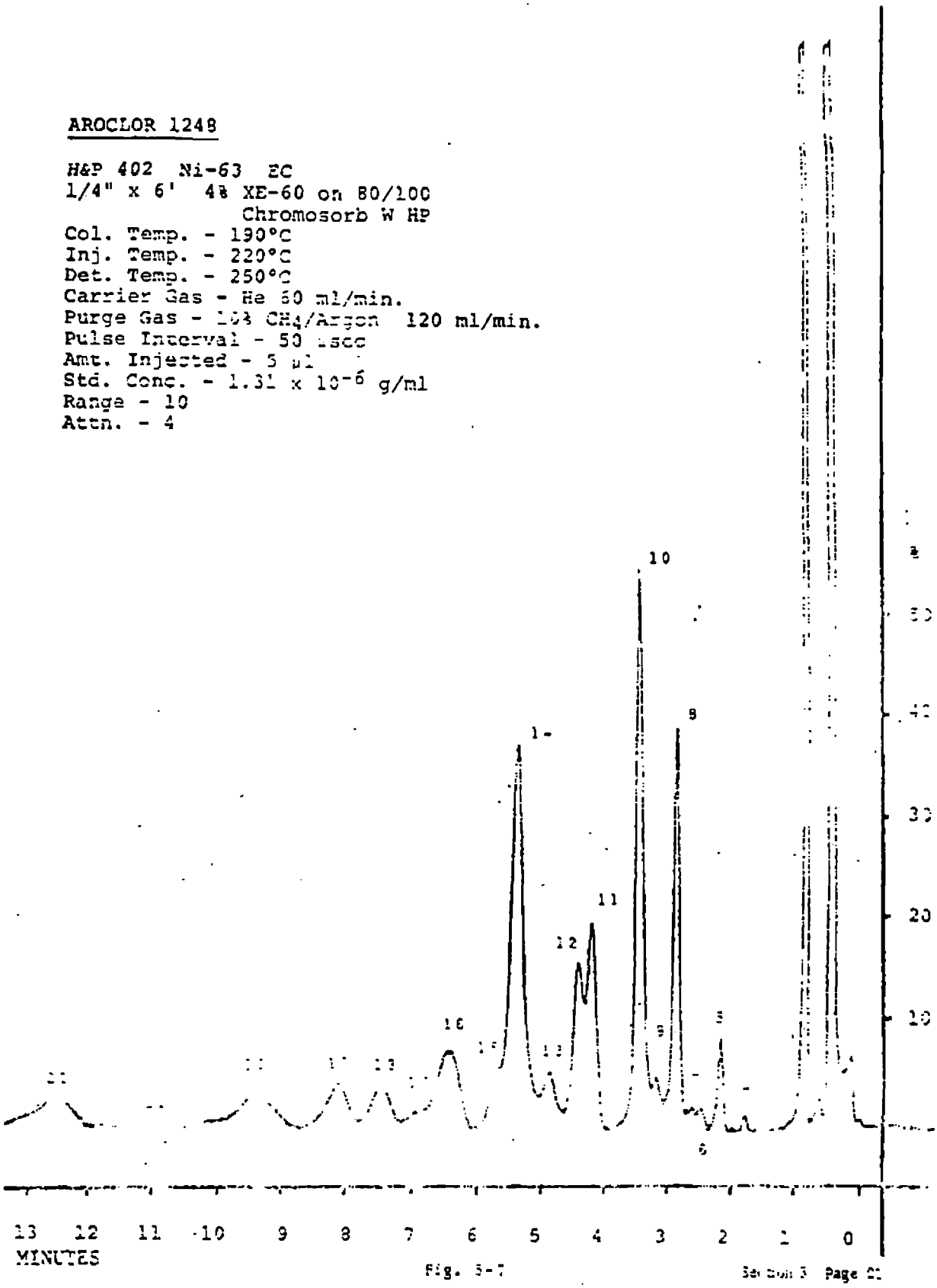


Fig. 3-7

NPC00007430

770069

AROCLOR 1254

H&P 402 Ni-63 EC
1/4" x 6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 205°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH_4/Argon 120 ml/min.
Pulse Interval - 50 usec
Amt. Injected - 5 µl
Std. Conc. - 1.02 x 10^{-6} g/ml
Range - 10
Attn. - 8

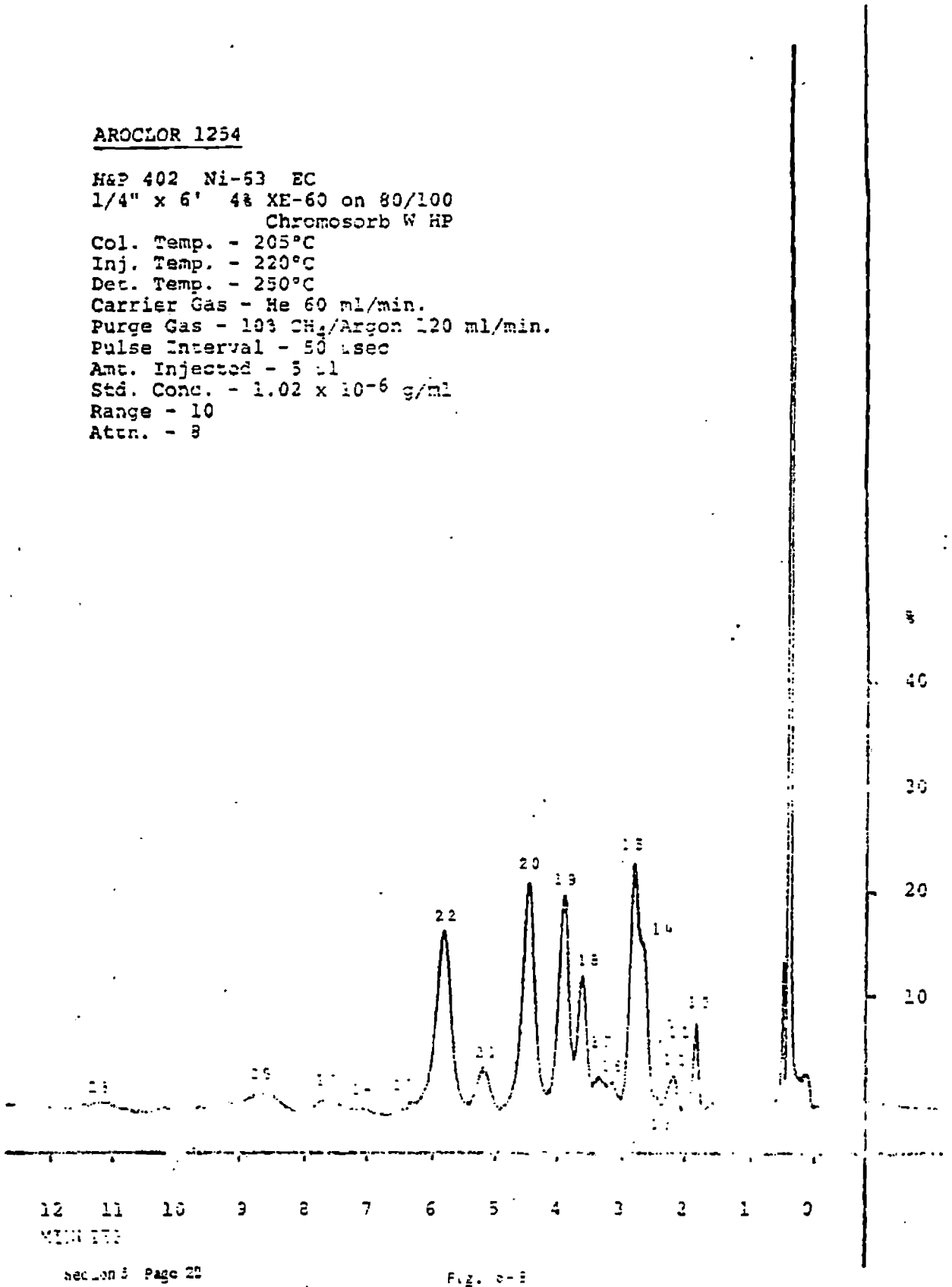


Fig. 3-8

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770070

AROCLOR 1260

H&P 402 Ni-63 EC
1/4" x 6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 220°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH4/Argon 120 ml/min.
Pulse Interval - 50 usec
Amt. Injected - 5 ul
Std. Conc. - 0.98 x 10-6 g/ml
Range - 10
Attn. - 8

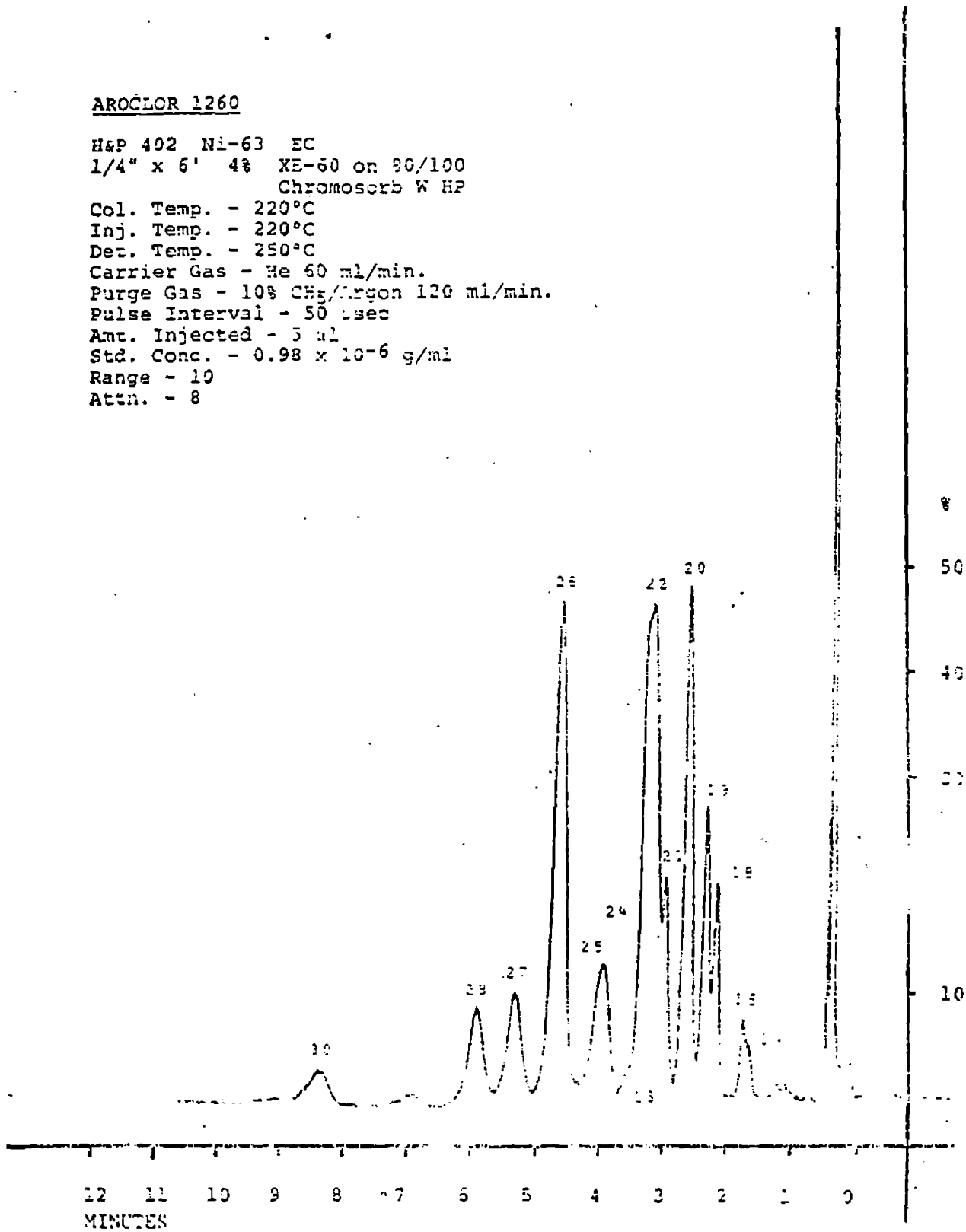


Fig. 8-9

NPC00007432

770071

MEMBER COMPANIES OF THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

Allis-Chalmers Manufacturing Co. †
Milwaukee, Wis. 53201

Central Moloney Transformer Division †
Colt Industries
Pine Bluff, Ark. 71601

Chance, A. B., Co. †
Transformer Division
Washington, Mo. 63090

Dowzer Electric Inc. †
(Division of Sola Basic Industries)
Mount Vernon, Ill. 62864

Esco Manufacturing Co. *
Greenville, Tex. 75401

Federal Pacific Electric Co.
New Bedford, Mass. 02744 *
Newark, N.J. 07101 †

General Electric Co.
[illegible] *
[illegible] †

Hevi-Duty Electric *
Division of Sola Basic Industries
Goldsboro, N.C. 27530

High Voltage Power Corp. *
Westboro, Mass. 01581

I-T-E Imperial Corp. †
Philadelphia, Pa. 19130

Kuhlman Electric Co., A Division of †
Kuhlman Corp.
Birmingham, Mich. 48012

Magnetics Inc. *
Sandy Lake, Pa. 16145

McGraw-Edison Power Systems Div.
St. Miles [illegible] *
[illegible] †

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Buffalo, N.Y. 14226

Northern Engineering Division *
Sta-rite Industries Inc.
Baraboo, Wis. 53913

Sangamo Electric Co. *
Springfield, Ill. 62705

Sierra Transformer Co., †
Cerritos, Calif. 90701

Sorgel Electric Corp. †
Subsidiary of Square D Co.
Milwaukee, Wis. [illegible]

Spokane Transformer Co. †
Spokane, Wash. 99202

Sprague Electric Co. *
North Adams, Mass. [illegible]

[illegible] Transformer Co. [illegible] *
Arthur Lee Sage and Mary M. [illegible]
Warren, Ohio [illegible]

[illegible] Electric [illegible] Co. *
[illegible] †

[illegible]

[illegible]

[illegible]
St. Louis, [illegible]

Westinghouse Electric Corp.
Bloomington, Ind. 47402 *
Sharon, Pa. 16146 *

[illegible]
[illegible]

* Member of Capacitor Section.
† Member of Transformer Section.

Printed in U.S.A.

NPC00007433

770072

Polychlorinated Biphenyls

Another Long-Life Widespread Chemical in the Environment

David B. Peakall and Jeffrey L. Lincer

The recent finding that pelagic birds dying on the coasts of Great Britian had polychlorinated biphenyls (PCBs) in their livers in concentrations of several hundred parts per million (Bourne and Mead, 1969) shows that these compounds are present in the ecosystem in large amounts. Thus, it seems worthwhile to summarize and evaluate our current knowledge of these compounds.

Structural and Physical Properties

The picture is complicated by the fact that we are not dealing with a single compound. The basic structure of PCBs is shown in Figure 1. Any of the positions marked with an X can be substituted by chlorine. Wadmark (1935) has calculated that the 209 possible compounds are all unique. His criteria for unique structures are those containing different numbers of chlorine atoms per molecule and the number of chlorine atoms per ring differing by an amount other than one.

The commercially available Aroclors (Monsanto Company Trademark) are designated by numbers (Monsanto Technical Bulletins). The first two digits represent the molecular type: 12 - chlorinated biphenyls, 25 and 44 - blends of chlorinated biphenyls and chlorinated terphenyls (75% biphenyl and 60% biphenyl, respectively); 54 - chlorinated terphenyls. The last two digits give the weight percent of chlorine. Thus Aroclor 1242 is a chlorinated biphenyl containing 42% chlorine. The [illegible] vary [illegible] from Monsanto range from [illegible] to Aroclor 1268 [illegible] of the [illegible] five contain six chlorine atoms, five contain seven chlorine atoms, and one containing eight. Bedford et al. (1970), studying Aroclor 1254, found 15 compounds: one containing three chlorine atoms, four containing four chlorines, four containing five chlorines, five containing six chlorines, and four containing seven chlorines. Thus, the number of compounds present is, fortunately, much smaller than is theoretically possible.

PCBs are chemically inert, are not hydrolyzed by water, and resist alkalies, acids, and corrosive chemicals. They have low volatility, their boiling points ranging from 278 C for Aroclor 1221 to 415 C for Aroclor 1268 (Penning, 1930). All are stable to prolonged heating at 150 C, and the lower Aroclors can be distilled at atmospheric pressure without appreciable decomposition. PCBs are described as insoluble in water and very soluble in hydrocarbon solvents, although no exact figures appear to be available. Nothing is known about the biological decomposition of PCBs, but it is likely that they are more stable than DDT and its metabolites since they lack the [illegible] hydrogen, the aromatic rings which is the site of [illegible] of most of the transformations of DDT. Thus, PCBs have the necessary physical and chemical characteristics for persistence and accumulation as the facts [illegible].

Use of PCBs

Polychlorinated biphenyls were first described in the literature in 1881 (Schmidt and Shultz, 1881), and the successful commercial production was achieved by the Swann Company in 1930. In their [illegible] physical characteristics and commercial possibilities of these materials was described by Penning (1930). PCBs were manufactured by Monsanto in the United States (Trade name Aroclors), Prodelec in France (Phenoclors), and Bayer in Germany (Colpheny). Other manufacturing [illegible] are located in Japan and the Soviet Union. No figures of the amount of these materials produced annually are available to us [illegible] to judge from the uses listed, it [illegible] they may be very large. The uses listed in the table are only suggested uses taken from Technical Bulletin 264 of the Monsanto Chemical Company, and [illegible] there is no information on the [illegible] which these [illegible] render the [illegible] short- [illegible] manufacturers of [illegible] and [illegible].

The [illegible] [illegible] natural [illegible] for [illegible] and [illegible] of [illegible] forming [illegible] [illegible] and [illegible] are more [illegible] under [illegible] [illegible] [illegible] of Aroclors. This possibility [illegible] consider [illegible] a number of [illegible] Sullivan and Storrs [illegible] (1953), Horn and Sullivan (1953), and Tsao et al. [illegible] found that the chlorinated terphenyl Aroclor 5460 increased the residual potence of lindane. Tsao et al. (1954) [illegible] covered that there was some indication [illegible] chlorinated [illegible] yphenyl may have a synergistic effect with lindane. Duda [illegible]

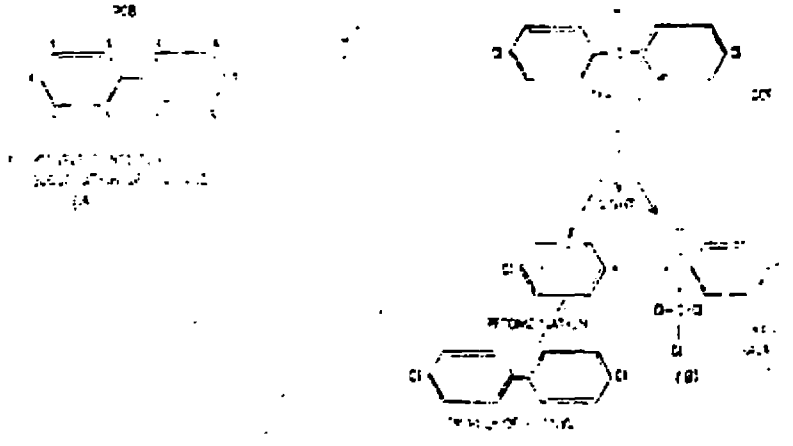


Fig. 1. Basic structure of PCBs. X's and possible [illegible] (PCBs).

[illegible] Research Center at the Langmuir Laboratory, Cornell University, Ithaca, NY

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[illegible] saplings with a lindane-Aroclor [illegible] mixture (1:4) and then tested [illegible] effect on the leaves to infestation with [illegible] beetle (*Galerucella luteola*). He found that leaves treated with lindane plus Aroclor were protected longer and that the insecticidal effect was more rapid than with lindane alone. Peaks corresponding to Aroclor 1260 have not been detected in the environment. However, under conditions of temperature and flow-rate commonly used for gas chromatographic analysis these compounds would not be detected (Reynolds, 1970).

Nearly 25 years ago it was noted that Aroclor 1242 was one of 175 compounds out of 6000 tested that was effective [illegible] mosquito (*Aedes*) larvae (Deonier et al., 1944). Lichtenstein et al. (1969) tested the effect of adding a variety of synergists and terpenoids to DDT and dieldrin with respect to their toxicity to house and fruit flies. It was found that PCBs had very low toxicity to house flies when given alone but PCBs increased the toxicity of dieldrin and DDT, especially to mites. The effectiveness of these compounds increased as the chlorine content [illegible]. For example, Aroclor 22 [illegible] the mortality of [illegible] 32%, whereas Aroclor 1254 [illegible].

Analytical Methods

Identification. Since various compounds [illegible] electron-capturing properties have been [illegible] in environmental samples in the past (Abbott et al., 1966), and some pesticides are capable of chlorinating in the soil to form a new compound (Bartha, 1969), it is important that the presence of PCBs in field samples be proven beyond doubt. Identification by means of a combination of high resolution gas chromatography and mass spectrometry has been carried out by three independent laboratories in Sweden (Widmark, 1967), Holland (Kaemen et al., 1970), and the United States (Bagley et al., 1970). Widmark's report states that [illegible] were identified by mass spectrometry although [illegible] were [illegible] a number of components gave [illegible] retention times, and Bagley et al. (1970) demonstrated that most chemicals in the field samples examined were components of Aroclor 1254. Thus, despite a recent statement by the Monsanto Chemical Company (in Risebrough, 1970) that the data for labeling the peaks in question as PCBs was not proven, there is enough evidence to convince an unbiased scientific jury.

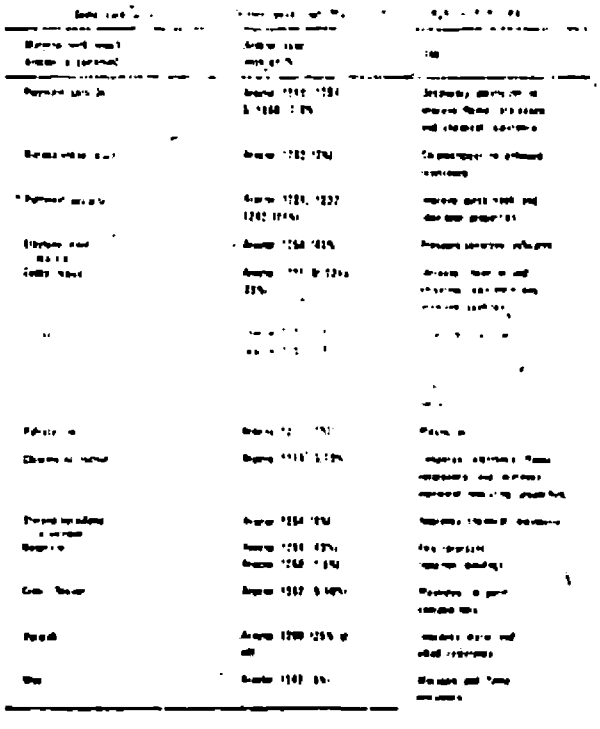
3) *Separation.* The chemical techniques preliminary to quantitation of residues in samples containing both PCBs and chlorinated hydrocarbon pesticides fall into two groups: those necessitating the destruction or alteration of one or more of the compounds and those which do not.

Included in the first group is nitration. Treatment with a 1:1 mixture of sulfuric acid-nitric acid at 0 C for 5 min destroys or alters aldrin, p,p'-DDE, p,p'-DDD (TDE), p,p'-DDT, and dieldrin such that they can no longer be detected at the original position on the chromatogram. This procedure leaves unaffected PCB, lindane, and BHC (Jensen and Widmark, 1967). A more rigorous nitration with a 1:1 mixture of sulfuric acid-fuming nitric acid for 15 min at room temperature removes, in addition to DDT and its related products, aldrin, heptachlor, Kelthane, Perthane, Tedion, Telodrin, and Trithion while lindane, heptachlor epoxide, toxaphene, and Strobane are not removed (Uthe et al., 1967). Risebrough et al. (1968) reported that this nitration also removed the chromatographic peaks of PCBs. Reynolds (1969) reported that his attempts to nitrate samples were not fully successful in that there appeared to be loss of some of the more volatile PCBs while peaks in the [illegible] region were produced. Armour and Burke (1970) recovered [illegible] complex chromatographic residues after nitration which could not be related to the unreacted DDT-PCB mixture, and nitration was not suggested as a practical means of separating DDT and PCB for [illegible] tests.

Saponification with alcoholic NaOH or KOH will destroy chlorinated pesticides. Toxaphene, DDD, and DDT in their respective olefins (Archer and Crosby, 1966; Klein and Watts, 1968). Risebrough et al. (1969) reported that PCB peaks are not removed or displaced but gave no data.

The second, and in some instances more desirable, group of analytical techniques allows the effective separation of many chlorinated hydrocarbon pesticides from PCBs. Reynolds (1969, 1970) reported on an activated florisil column technique which separated heptachlor, aldrin, DDE, and PCB with the first elution (60 ml n-hexane) from lindane, heptachlor epoxide, DDD, and DDT with the second elution (40 ml 50% ethyl ether in hexane). Armour and Burke (1970) developed a method using a silica gel-Celite column to separate aldrin and PCB with the first fraction (200 ml petroleum ether), and lindane, heptachlor, heptachlor epoxide, dieldrin, endrin, p,p'-DDE, o,p'-DDT, p,p'-DDT, and p,p'-DDD with the second fraction (200 ml acetonitrile-hexane mixture saturated with [illegible]). Sherma et al. (1969), using [illegible] activated florisil, [illegible] for separating [illegible] containing DDE and PCB with hexane, and then dieldrin and endrin with [illegible] ethyl ether in hexane. Mumma and Lee (1969) reported on a method which utilized silica gel-[illegible]

Table I



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and a hexane/ethyl ether (98:2) solvent system. The plates were developed, sprayed with a silver nitrate solution, and exposed to UV light. The plates were then divided into five horizontal sections. Dieldrin, endrin, γ-BHC, heptachlor epoxide, p,p'-DDD, o,p'-DDT, p,p'-DDT, and p,p'-DDE (in that order) were found in the first four fractions, while most of the interfering compounds found in wildlife samples were found in the fifth zone. Bagley et al. (1970) used this method but mentioned that zones three and four contained practically all unknown components as well as p,p'-DDT (zone three) and p,p'-DDE (zone four). Armour and Burke (1969) used precoated (aluminum oxide) sheets and n-heptane and 2% acetone/n-heptane for solvent systems. PCBs (Aroclors 1254 and 1260) and DDE were not separated, but p,p'-DDT and p,p'-DDD were completely separated from PCB by both solvent systems. Another possible means of separating interfering substances is to use a series of differing polarity columns in the gas chromatograph at the time of determination. This is less time consuming and may be useful when operating conditions can be selected such that PCB peaks are absent in the region where sought pesticides emerge (Simmons and Tatton, 1967).

In [illegible] Koeman et al. (1969) semiquantitatively measured the residues in Japanese quail fed chlorinated DPs by using one of the peaks in a [illegible] DPs mixture as a standard. Risebrough (1969) quantitated relative levels of PCBs by assuming that each PCB compound produced the same peak height with the electron capture detector as the same amount by weight of p,p'-DDE. After summing the heights of the individual peaks, the total was multiplied by a factor derived from measurements of standard solutions with electron capture and microcoulometric detectors. Jensen et al. (1969) reported PCB amounts as the sum of all PCB components and based the [illegible] on a combination of mass spectrometry and microcoulometric and electron [illegible] [illegible]. Even with [illegible] [illegible] these measurements [illegible] [illegible] is still rough and [illegible] [illegible] than a factor of 2. Anderson et al. (1969) devised a method for obtaining a crude estimate of PCB residues as Aroclor 1254 from chromatograms where separation had not been attempted. On an empirical basis, it was found that Aroclor 1254 could be quantitated by considering peak 10 as p,p'-DDT and multiplying that value by 10. Since this peak had originally been quantitated as p,p'-DDT, and in fact many of the original samples contained little or no p,p'-DDT, it was possible to estimate relative PCB values. Anderson and his co-workers also saponified samples to remove interfering p,p'-DDT and p,p'-TDE and then quantitated PCBs as Aroclor 1254 by relating sample peaks 9 and 10 to the corresponding peaks of an Aroclor 1254 standard. Reynolds (1970) employed a method similar to Koeman et al. (1969) but based his quantitation on an average of two or more peaks. In addition, his results were reported as Aroclor 1254 or 1260 depending on the overall pattern of the chromatographic peak profile. It is clear that we are still relatively unsophisticated in our PCB quantitation methodology and will continue to estimate only relative amounts of PCBs in field samples until we synthesize the individual PCB components commonly found in the ecosystem and are able to speak in terms of these individual peaks as we do for most pesticide residues. However, it has been kindly pointed out (Risebrough, pers. comm.) that, with reference to biological significance, the correct order of magnitude and accurate relative amounts of PCB give the essential information. This is because biological effects, such as enzyme induction, are related to degree of chlorination, and the [illegible] [illegible] [illegible] some indication of the activity. Therefore [illegible] information would be lost if stress were placed only upon quantitating individual peaks.

4) *Magnitude of Error.* Ever since PCB peaks were recognized for what they are, residue chemists and other researchers interested in pesticide residues have asked what magnitude of error is likely to result from ignoring the presence of PCBs. Only recently have studies either directly or indirectly resulted in an estimate of this error. Anderson et al. (1969) quantitated p,p'-DDE, p,p'-DDD, and p,p'-DDT in five egg samples before and after saponification. There was no appreciable change in the p,p'-DDE but apparent p,p'-DDD [illegible]

[illegible] ... the apparent residues represented from 0 to 7% in California gull (*Larus occidentalis*) fat, 0% in cormorant (*Phalacrocorax auritus*) eggs, 80% in 10 pooled mallard (*Anas platyrhynchos*) duck eggs, and from 0 to 6% in great blue heron (*Ardea herodias*) eggs. Respective values for p,p'-DDT were 0 to 53%, 13 to 41%, 100%, and 18 to 102%. Actual residue levels of heptachlor epoxide generally remained [illegible] of the apparent values before and [illegible] values for p,p'-DDE and dieldrin were not significantly different. Obviously, the magnitude of error may vary depending on the trophic level sampled and certainly with the area from which a sample is collected (Risebrough et al., 1968; Jensen et al., 1969). Since the publishing of adequate separation techniques, there is no reason why there should be any error in pesticide quantitation contributed by PCBs.

Toxicology

Despite some recent studies, the toxicology of PCBs remains rather poorly known as compared to that of the chlorinated hydrocarbon pesticides. For example, no definite work has been done to establish LD50 values for the various formulations of PCBs.

1) *Acute, single dose experiments.* Tucker and Crabtree (1970) found that a single dose of 100 mg/kg Aroclor 1254 (stomach tubed in oil) was fatal to two out of three rats, while 500 mg/kg was not fatal to three rats. Aroclor 1268 killed one rat out of three at 500 mg/kg, 1000 mg/kg, 2000 mg/kg, and 4000 mg/kg. Smyth (1931) [illegible] [illegible]

2) *Acute, feeding experiments.* Monsanto Bulletin [illegible] states that 100 ppm diet had no effect on rats, although [illegible] details of the studies were given. The experiment of Bennett et al. (1938) in which 0.05 g/rat of [illegible] chlorine biphenyl was given orally every other day led to 50% mortality. If one assumes a body weight of 200 g [illegible]

[illegible] ... this gives a dose of 125 mg/kg. Tucker and Crabtree (1970) fed rats diets containing 10 and 1000 ppm Aroclor 1254. One rat out of six on the low dose diet, this mortality was considered to be due to other causes; four out of four of the high group died within 53 days and the [illegible] 1330–1520 mg/kg. The

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food intake of the 1000 ppm group was only 79% of the control group.

Prestt et al. (1970) have examined the toxicity of Aroclor 1254 to Bengalese finches (*Lonchura striata*). This is a difficult species for which to calculate the dietary intake. Due to their dependence upon unshelled food, it is only possible to present the PCB-laden food for a few hours a day (Jefferies, 1967). Loss by evaporation and loss by spillage must be allowed for, and increase of weight by defecation must be kept to a minimum. Thus, the calculated dietary intake is subject to more error than is usually the case. Prestt et al. (1970) also measured the concentration of PCBs in the liver; they found that the range was large (i.e., 70-697 ppm in birds that died compared to 3-634 ppm in those that survived). These authors conclude that Aroclor 1254 has only 1/13 the toxicity of DDT, although the different shape of the mortality curves—steep with DDT, gradual with PCB—makes comparison difficult. Jefferies and Walker (1966) found good correlation between calculated dietary intake and liver concentrations for pp'-DDT in the Bengalese finch. However, other workers (Dale et al., 1963; Stickel et al., ...; Stickel and Stickel, 1969) have concluded that levels in the brain are a more ... of toxic levels than those in ... or whole carcass.

... and Koeman (1970) fed Phenoclor DP6, ... and Aroclor 1260 ... a dosage of 400 ppm. Mortality was complete (20/20) for those birds ... Phenoclor in 12-55 days and in 13-29 ... Clophen. The mortality for Aroclor was only ...% for a 60-day period. This difference ... the ... in the liver and, for some ..., for chickens dying during the ... Although there was considerable variation, most of the brain levels were between 200 and 400 ppm, which ... compared to 50-80 ppm for DDT ... et al., 1966). On the basis of this ... PCB ... as toxic as DDT. ... was noted between the ... different PCB formulations, ... the numbers of determinations involved was rather small. If this finding ... by subsequent work, it would ... that a differential absorption from ... or differential penetration of the ... brain barrier is involved. The liver ... were more variable. There was a ... number in the 200-400 ppm ... but there were several values in excess of 2000 ppm. This finding is in agreement with the findings of Dale, Stickel, and co-workers that the brain levels are the best indication of acute toxic levels.

McCune et al. (1962) found no mortality with chickens fed 100 or 200 ppm Aroclor 1242 in their diet for a 4-week period. On diets of 400 ppm and 800 ppm, the mortalities over a 4-week period were, respectively, 50% and 90%. During the first 3 weeks, the mortality figures were 10% and 50%, respectively. Flick et al. (1965), using the same material at 400 ppm in the diet, had three birds out of 24 die in a 3-week period. Koeman et al. (1969a) found that a diet containing 2000 ppm Phenoclor DP6 caused complete mortality with Japanese quail (5/5) in 5-13 days and rats (8/8) in 1-56 days.

Schoettger (unpublished) found that the 96-hr TLm for Aroclor 1221 using cutthroat trout was 1.2 mg/l and for Aroclor 1260 was 60.9 mg/l. In general, they found that the toxicity of Aroclors was inversely proportional to their percentage chlorination and directly proportional to their solubilities. These figures suggest that PCBs are two to three orders of magnitude less toxic to ... than DDT. ... by Lichtenstein et al. (1969) on house and fruit flies found that PCBs were 40-300 times less toxic than DDT, the toxicity decreasing as the chlorine content increased. Thus, ... that the lower vertebrates and invertebrates are much less susceptible than mammals to direct toxicity from PCBs.

b. Sublethal effects. As with the chlorinated hydrocarbon pesticides, the most important effects are long-range sublethal effects. The ... changes in various organs are summarized in Table 2. The table shows ...

... kidney ... and ... spleen ... found in ...

McLaughlin et al. ... mg Aroclor 1242 ...

... young ... edema, ... growth ...

Induction of hepatic hydroxylating enzymes has been demonstrated in the pigeon (Risebrough et al., 1968), rat (Street et al., 1969), and American kestrel (*Falco sparverius*) (Lincer and Peakall, 1970). Street and co-workers studied the effects of a diet of 50 ppm and 100 ppm on sleeping time induced by a standard dose of hexobarbital, in vitro rates of aniline hydroxylation and demethylation of p-nitroanisole, and the rate of excretion of dieldrin. These workers studied 12 compounds ranging in chlorine content from 21% to 68% and found that all the effects increased with increasing chlorine content. For example, 50 ppm of Aroclor 1221 reduced hexobarbital sleeping time by 11%, whereas for Aroclor 1248 and 1268 the figures were, respectively, 35% and 48%. Thus, the sublethal effects have direct correlation with chlorine content, while the lethal effects appear to be inversely correlated (Tucker and Crabtree, in press). Lincer and Peakall (1970) noted an increase of the in vitro rate of metabolism of estradiol in kestrels fed 0.5 and 5 ppm Aroclor 1254 in their diet and also demonstrated increased levels of cytoplasmic RNA with the higher dietary level using a cytophotometric technique.

Tucker (unpublished) found that a single oral dose of 500 mg/kg Aroclor 1254 caused regular egg laying of Japanese quail (*Coturnix coturnix*) to turn first to scattered egg production and then to stop completely for a week. The scattered eggs had shells 9% thinner than normal, but thickness returned to control values when regular laying was resumed. Mallard ducks fed ... mg/kg of Aroclor ... normal after resumption of regular laying. The period before egg laying ... noted ... Peakall ... it is possible that the ... increased rate of metabolism ...

... Levels of PCBs ... Nature

... 1966 ... eggs of wild birds in ... first identification of these materials was by Jensen ... stated (Anonymous, 1966) that residues in feathers collected in Sweden go back to 1944. PCB residues have been reported in wildlife from Canada (Holden and Marsden, 1967; Anderson et al., 1969; Reynolds,

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TABLE 2. Pathologic changes induced by PCBs

Treatment	Animal	Liver	Kidney	Pericardium and Peritoneum	Other Observable Changes	References
Single oral dose of 69 mg (42% cl)	Guinea Pig Rat Rabbit	Small fat droplets through lobules, slight to moderate central atrophy, focal necrosis noted in a few animals	Essentially normal	No noteworthy changes	Adrenals, spleen, and pancreas showed no noteworthy changes.	Miller (1944)
100 mg daily for 6 days (65% Cl)	Rat	Cells swollen, hyaline granules present, most died within few days				Bennett et al. (1938)
50 mg daily for up to 6 months 65% Cl)	Rat	Enlarged (33% weight increase), large number of hyaline globules in cytoplasm. Several died during experiment.				Bennett
25, 50, & 100 ppm in diet for 15 days (21-68% Cl Aroclors)	Rat	Increase in weight, effect increasing with increasing chlorine content. Aroclor 1232-16%, 1242-12%, 1254-14%, 1268-24% at 50 ppm.				Street et al. (in press)
100 ppm in diet 200 ppm in diet 400 ppm in diet 800 ppm in diet (Aroclor 1242)	Chicken	No effect No effect Enlarged and mottled Damaged	Damaged	Slight Hydropericardium Hydropericardium Hydropericardium, hydroperitoneum, Enlarged.		McCune et al. (1962)
200 & 400 ppm in diet for 3 weeks (42%, Aroclor)	Chicken	No changes noted	Paleness at 200 ppm, extensive hemorrhage, and enlargement at 400 ppm	Increased fluid in pericardial sac at the higher concentration.	Paleness of pancreas, enlargement of adrenal and small spleen at low concentrations. At higher concentrations, [illegible] pancreas, adrenals [illegible]	Flick et al. (1965)
[illegible]	[illegible]	[illegible]	[illegible] 53.5% [illegible]	[illegible]		[illegible]
400 ppm in diet for 52 days (52% Cl)	[illegible]	[illegible] 2.76 g/100 g to 4.25 g/100 g [illegible] Fatty degeneration.	[illegible] 1 and 2 [illegible]	Hydropericardium common [illegible] 1 and 2. Rare with [illegible]	Increased [illegible] 1 and 2) Spleen [illegible] 0.145 g/100 g [illegible]	[illegible]

[illegible]

[illegible] 1970), Germany (Fruczynski and Wendland, 1968; Koeman et al., 1967), Great Britain (Holmes et al., 1967; Prestt and [illegible] 1967; Prestt et al., 1970; [illegible] Marsden, 1967), Netherlands (Koeman et al., [illegible] 1969), Sweden (Anonymous, 1966; Jensen et al., 1969), and the [illegible] (Anderson et al., [illegible] Risebrough [illegible] 1969 [illegible]).

Biological Magnification

No detailed studies, such as those for DDD at Clear Lake (Hunt and Bischoff, 1960) and DDT and its metabolites in Lake Michigan (Hickey et al., 1966), have yet been made for PCBs.

The most detailed studies currently available are those of Jensen et al. (1969). The figures (mean, range of values, and sample size) given in the table below are taken from their paper.

PCBs (ppm in extractable fat)	Range	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Sea [illegible]	[illegible]	[illegible]	[illegible]
Guillemot eggs	250 [illegible]	—	
White-tailed Eagle			
Pectoral muscle	—	[illegible]	[illegible]
Brain	—	[illegible]	[illegible]
Eggs	—	540 (220-800)	[illegible]
Heron	—	[illegible]	[illegible]

The levels in three species of fish in Clear Lake in 1968 were 0.03-0.005 ppm (wet weight) compared to 0.098 ppm in the breast muscle of a western grebe (Risebrough et al., 1969). Anderson et al. (1969) found that in most fish extracts the levels of PCBs were less than 0.1 ppm, whereas the [illegible] [illegible] 0.3 ppm [illegible] [illegible] 0 ppm (wet weight) and feeders up to 10 ppm, mammal eaters to 50 ppm, and insectivores to 1 ppm. Unfortunately, no average values or prey items were included.

The physical properties of PCB and the available residue data clearly indicate that these materials are capable of biological magnification up the food chain

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Ratio of DDT to PCB

Risebrough et al. (1968) and Risebrough (1970) have examined the ratio of total DDT, i.e., DDT and its metabolites to PCB. He has found that the ratio DDT/PCB was 1-2 in San Francisco Bay and 5-10 for seabirds in the Pacific, in the Gulf of California, a region relatively remote from contamination, the ratio was 9-10. Vermeer (quoted in Reynolds, 1970) in western Canada found a DDE/PCB ratio of 7 for California gull tissues and 13 for great blue heron eggs. In the Baltic the ratio was 1-2 (Jensen et al., 1969), although along the west coast of Sweden the ratio was as low as 0.15. In grebes in the British Isles the ratio was 0.4-0.8 (Prestt and Jefferies, 1969). For sea-bird eggs, Prestt et al. (unpublished) found ratios of 1.06 to 0.5.

The overall impression is that the amount of PCB in tissues tends to parallel that of DDE, at least in local ecosystems, and the DDE/PCB ratio is lowest near industrial areas suggesting that PCB is not carried quite so readily to remote areas. Nevertheless, the variation of the ratio is small enough to suggest that the factors of general are similar. Since the [illegible] reports to aerial [illegible] the route [illegible] of the chlorinated hydrocarbon [illegible] PCBs [illegible] for PCBs [illegible] PCB residues in [illegible] are not known, although the [illegible] have recently received [illegible] Risebrough, 1970, Reynolds, 1970). Since a large number of [illegible] may contain PCBs (Table 1), the most likely route is combustion of these materials. This suggestion remains to be tested. The possibility that PCBs could be derived from DDT should also be considered. The possibility that this conversion occurs in tissues is most unlikely for two reasons. First, it has never been detected despite the detailed work on the metabolism of DDT. Second, the [illegible] would be [illegible] for the [illegible] PCBs [illegible] While the results [illegible] Further [illegible] to [illegible] of dichloroethanes, [illegible] envision the formation [illegible] chlorinated biphenyls by [illegible] Since PCBs extracted from [illegible] match well with higher [illegible] i.e., 1254), it seems unlikely that [illegible] found in nature could be derived [illegible] other materials.

Significance of Current Levels

In view of the similarity of PCBs to DDT and its metabolites, the addition of PCB residues to the environment is roughly equivalent to an increase of DDE residues. However, since a synergistic effect of PCBs on DDT has been demonstrated in insects (Tsuto et al., 1953), this possibility should not be overlooked in higher organisms. The enzyme induction effects of PCBs have been well documented, and carbonic anhydrase inhibition is likely. The effect of PCBs on photosynthesis is a critical experiment that has not been done. Wurster's (1968) experiments with phytoplankton should be repeated with PCBs.

The most critical area for research on PCBs is to discover the major source(s) of escape into the environment. Legislative control of a material escaping as a side effect of its use may have a different set of problems than the control of pesticides which are broadcast as a function of their normal use. The evidence suggests that it is important to find the leak and stop it.

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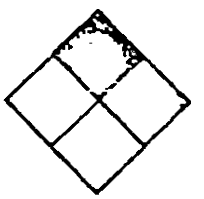
Chemical Hazards Bulletin

AMERICAN INSURANCE ASSOCIATION 85 JOHN STREET, NEW YORK, N.Y. 10038

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POLYCHLORINATED BIPHENYLS

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(1,14,16,19,20,23,24,26)

At one time, fires in oil-insulated transformers resulted principally from the breakdown of insulation caused by an overload, switching or lightning surges, gradual deterioration of the oil level, moisture in the oil, or failure of the metallic grounding. Arcing that followed electrical breakdown would char the paper insulation and decompose the oil, producing gases which would build up pressure within the transformer case. If the pressure became great enough, the case would rupture, and an explosion would follow. It is for this reason that fire-retardant transformer oils were developed. The class of materials that were most widely used and recognized were the "chlorinated biphenyls". Chlorinated biphenyls is a generic term describing compounds that can have various combinations of chlorine atoms attached at as many as ten positions in the molecule.

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THESE REPORTS ARE PREPARED [illegible]

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A total of 209 compounds qualify as chlorinated biphenyls and they are collectively referred to as polychlorinated biphenyls, or PCBs, although many are not actually polychlorinated. PCB compounds contain from 12 to 68 percent chlorine.

The PCBs are manufactured by the chlorination of biphenyl and anhydrous chlorine using iron filings or ferric chloride as a catalyst.

Polychlorinated biphenyls, used either alone or in blends with other materials such as trichlorobenzene meet the need for a fire-retardant dielectric fluid with a high resistivity, a high dielectric strength, a relatively high dielectric constant, and a very low power factor. By replacing the previously used hydrocarbon oil with polychlorinated biphenyls or mixtures of polychlorinated biphenyls with trichlorobenzene, it has been possible to redesign equipment with a great reduction in size for the same capacity and voltage. At the same time, the fire hazards have been elminated.

Askarel, a term often used in place of polychlorinated biphenyls, is an American Society for Testing and Materials (ASTM) designation for insulating (dielectric) fluids which releases only nonflammable, nonexplosive gases if decomposed by an electric arc. Examples are pentachlorodiphenyl and trichlorobenzene, but also included are pentachloridiphenyl oxide, pentachlorophenylbenzoate, hexachlorodiphenylmethane, pentachlorodiphenyl ketone, and pentachloroethylbenzene.

All of these materials are fire-retardant, noncorrosive, have a high dielectric strength, and chemically are incredibly stable. Although most individual polychlorinated biphenyls are solids at room temperatures, the mixtures vary in consistency from light oils to viscous liquids or sticky resins. The polychlorinated biphenyls do not readily degrade. They persist and, if discarded in the environment in sufficient volume, a gradual accumulation in certain ecological systems results. The very high stability that makes them invaluable in transformers and capacitors is the reason that their disposal must be properly controlled.

PCBs are generally prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of iron filings or a ferric chloride catalyst. Trace quantities of chlorinated naphthalene and chlorinated dibenzofurans have been reported in some chemical samples of PCBs and it has been suggested by several researchers that the presence of these impurities may be of toxicological significance. The compounds were long thought to be relatively inert and [illegible] about 1966, a Swedish scientist discovered PCB residues in fish and [illegible]. Since [illegible], PCBs have been detected, sometimes in high concentrations in [illegible] animals, in rivers and lakes, in bottom sediments, and even in foods.

The Environmental Protection Administration (EPA) has estimated that 1.5 billion pounds of PCBs have been sold in the U.S. since 1929. They estimated that approximately 750 million pounds are currently in service. The remainder has been dumped in landfills, leached into the water or degraded into harmless compounds.

[illegible]

PCB production is now down to 40 million lbs year and used solely in closed electrical systems; e.g. transformers and capacitors. Approximately 400,000 pounds of PCBs were imported to the U.S. in 1974.

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The principal alternative to PCBs for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1932 level and would necessitate the redesign and replacement of such widely used equipment as fluorescent light fixtures and racks for power and induction-heating capacitors, which could not now accomodate the increased size of oil capacitors while maintaining their present ratings.

The cost of PCB liquids is about five to ten times more than mineral oil. Thus, long before there were any environmental concerns about PCBs, there was a strong economic incentive to find other, less expensive insulating liquids with the desireable characteristics of PCBs. Since the 1930s, at least ten major chemical or electrical companies have invested large amounts of time and money in this search, all with no success. Although potential substitutes that are more costly than PCBs (such as fluorinated liquids) have also received some consideration, little is known about either their electrical performances or possible ill effects upon the environment. Today, because of the concern of PCBs on the environment and its health hazards, several companies are studying new materials that can be used as replacements for the PCBs. Some of those under current study are described in the "Control Procedures" section.

PROPERTIES (2,7,12,14,15,16,18,20,21,23,24)

Table I lists several properties of many different polychlorinated biphenyls. Table II lists the common tradenames for known PCB containing products.

Commercial PCBs are generally mixtures of many different polychlorinated biphenyls that are shown in Table I. Mixtures are manufactured to meet operational specifications, such as dielectric constant, flash point, fire point, density, per cent chlorine, and color. These commercial mixtures may vary from batch to batch. Table III describes the chemical makeup of several commercial PCB mixtures.

OSHA (17)

Under Title 29 - Labor; Chapter XVII - Occupational Safety and Health Administration, Department of Labor; Part 1910 - Occupational Safety and Health Standards, the safety and health of the employees are covered by the Standards of the Act. All re[illegible] shall be observed.

[illegible]

[illegible]

Cautionar[illegible] [illegible] bi[illegible]

For exa[illegible] of trade[illegible]

"This product contains Polychlorinated Biphenyls (PCBs). Care should be tak[illegible] to prevent entry into the environment through spills, leakage, use, vaporization, or disposal of liquid or containers. Avoid prolonged breathing of vapors or mists. Avoid contact with eyes or prolonged contact with skin. If skin contact occurs, remove by washing with soap and water. Following eye contact, flush with water. In case of spillage onto clothing, the clothing should be removed as soon as practical, skin washed, and clothing laundered."

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PROPERTIES OF VARIOUS BIPHENYLS

	FORMULA	FORMULA WEIGHT(a)	BOILING PT., °C(°F)
2 - Chlorobiphenyl	$C_{12}H_9Cl$	188.5	274 (525.2)
3 - Chlorobiphenyl	$C_{12}H_9Cl$	188.5	284 (543.2)
4 - Chlorobiphenyl	$C_{12}H_9Cl$	188.5	77.5x(171.5)
2 - 2' - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	59 (138.2)
2, 3' - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	73 (163.4)
4, 4' - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	150 (302.0)
2,3 - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	95 (203)
2,5 - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	
3,4 - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	85 (185)
3,5 - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	
2,4' - Dichlorobiphenyl	$C_{12}H_8Cl_2$	223.0	64 (147.2)
2,4,5 - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	78 (172.4)
2,3,5 - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	61 (141.8)
2,4,4' - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	55.5x(131.9)
2,5,4' - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	67 (152.6)
2,3,4' - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	88 (190.4)
2,4,2' - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	65 (149.0)
2,5,2' - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	58 (136.4)
2,4,3' - Trichlorobiphenyl	$C_{12}H_7Cl_3$	257.5	82 (179.6)
2,4,3',4' - Tetrachlorobiphenyl	$C_{12}H_6Cl_4$	292.0	122 (251.6)
2,4,2',5' - Tetrachlorobiphenyl	$C_{12}H_6Cl_4$	292.0	101 (213.8)
2,4,2',4' - Tetrachlorobiphenyl	$C_{12}H_6Cl_4$	292.0	150 (302.0)
2,3,3',5' - Tetrachlorobiphenyl	$C_{12}H_6Cl_4$	292.0	107 (224.6)
2,4,2',6' - Tetrachlorobiphenyl	$C_{12}H_6Cl_4$	292.0	81 (178.0)
2,3,2',5' - Tetrachlorobiphenyl	$C_{12}H_6Cl_4$	292.0	84 (183.2)
2,4,5,2',5' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	113 (235.4)
2,4,5,3',4' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$		114 (237.2)
2,4,6,2',6' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326	144 (291.2)
2,4,5,2',4' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	134 (273.2)
2,4,5,3',5' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	127 (260.6)
2,4,5,2',3' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	148 (298.4)
2,3,5,2',5' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	138 (280.4)
2,4,5,3',6' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	133 (271.4)
2,3,5,2',6' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	125 (257.0)
2,3,5,3',4' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	153 (307.4)
2,3,5,3',5' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	135 (275.0)
2,3,4,2',4' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	142 (287.6)
2,3,4,2',5' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	124 (255.2)
2,3,4,3',4' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	170 (338.0)
2,3,4,3',5' - Pentachlorobiphenyl	$C_{12}H_5Cl_5$	326.5	152 (305.6)
2,4,6,2',4',6' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	161 (321.8)
2,4,5,2',4',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	168 (334.4)
2,4,5,3',4',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	199 (390.2)
2,3,5,2',4',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	174 (345.2)
2,3,5,2',3',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	175 (347.0)
2,3,5,2',3',4' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	178 (352.4)
2,3,5,2',3',6' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	165 (329.0)
2,3,5,3',4',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	201 (393.8)
2,3,4,2',4',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	178 (352.4)
2,3,4,2',3',4' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	188 (370.4)
2,3,4,2',3',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	178 (352.4)
2,3,4,3',4',5' - Hexachlorobiphenyl	$C_{12}H_4Cl_6$	360.9	203 (397.4)
2,3,4,2',3',4',5' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,5,2',3',4',5' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,5,2',3',4',6' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,5,3',4',5',6' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,4,2',3',4',5' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,4,2',3',4',6' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,4,3',4',5',6' - Heptachlorobiphenyl	$C_{12}H_3Cl_7$	395.4	193 (379.4)
2,3,4,2',3',4',5',6' - Octachlorobiphenyl	$C_{12}H_2Cl_8$	430.3	221 (429.8)
2,3,5,2',3',4',5',6' - Octachlorobiphenyl	$C_{12}H_2Cl_8$	430.3	221 (429.8)
Decachlorobiphenyl	$C_{12}Cl_{10}$	498.7	306 (582.8)

TABLE I

Boil. Pt., °F. (°C)	SPECIFIC GRAVITY	SOLUBILITY			TLV(1975) TWA(1975)	FLASH POINT, °C.(°F.); TOC
		WATER	ALCOHOL	ETHER		
261.3 ([illegible])		[illegible].	v. sol.			
265.3 ([illegible])						
252 (122.0)		insol.	v. sol.			
329 ([illegible])		insol.	v. sol.	v.sol.		
311 (154.4)		insol.	v.sl.sol.	sl.sol.		
[illegible]						
[illegible]						
[illegible]						
[illegible]						
	1.4-1.5				421 Chlorine - "Skin" Entering (SRA)	
					3ct Chlorine - "Skin" Entering (OSHA)	
		v.s., sol.	v.sol.(hot)	sl.sol.		
195 Zn(381-420)						
240-280(464-536)		insol.	v.sl.sol.	v.sl.sol.		421 Chlorine-176-180 (3-8.8 - 356.0)
						367. Chlorine - None

TABLE II

TRADENAMES FOR KNOWN PCB CONTAINING PRODUCTS

TRADE NAME	TRADENAME OWNER (MANUFACTURER)
Abestol	American Corp. (USA)
Aroclor	Monsanto Company (USA)
Chlorextol	Allis-Chalmers (USA)
Clophen	Farbenfabricken Bayer GmbH (Germany)
Diaclor	Sangamo Electric (USA)
Dykanol	Federal Pacific Electric Co. (USA)
Decachlorodiphenyl (DK)	Caffaro S.P.A. (Italy)
Elemex	McGraw Edison (USA)
Fenclor	Caffaro S.P.S. (Italy)
Hyvol	Aerovox
Inerteen	Westinghouse Electric Corp. USA)
Kanechlor	Kanegafuchi Chemical Industry Co. Ltd. (Ja
Noflamol	Wagner Electric Corporation USA)
Phenoclor	Prodelec (France)
Pyralene	Prodelec (France)
Pyranol	General Electric Co. (USA)
Saf-T-Kuhl	Kuhlman Electric (USA)
Santotherm	Mitsubishi-Monsanto (Japan)
Sovol	U.S.S.R.
Therminol*	Monsanto Co. (USA)

*Therminol products now formulated in the U.S. do not contain PCBs.

Note: PCB-containing dielectrics (electrical insulators) are generally referred to as "askarels" in the electrical industry.

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TABLE III

DESCRIPTION OF PCB MIXTURES

	Aroclor 1221*	Aroclor 1016*	Aroclor 1242*	Aroclor 1254*	Aroclor 1260*	Kanechlor 300‡	Kanechlor 400‡	Kanechlor 500‡
Approximate Chlorine Content	21%	42%	42%	54%	60%	42%	48%	5?
Components								
Biphenyl	11	< 0.1	< 01	< 01				
Monochlorobiphenyls	51	1	1	< 1				
Dichlorobiphenyls	32	20	16	05		17	3	
Trichlorobiphenyls	4	57	49	1		60	33	5
Tetrachlorobiphenyls	2	21	25	21		23	44	27
Pentachlorobiphenyls	05	1	8	48	12	Qu	16	55
Hexachlorobiphenyls	none detected	< 01	1	21	38		5	13
Heptachlorobiphenyls	none detected	none detected	< 01	6	41			
Octachlorobiphenyls	none detected	none detected	none detected	none detected	8			
Nonachlorobiphenyls					1			

It must be emphasized that these are approximate compositions of the PCB mixtures and that a particular product may vary in chemical composition from batch to batch. *Weight-weight percent. None detected = less than 0.01%. Source of component composition, Monsanto Company, quoted in Hutzinger, O. et al, op. cit, p. 23. ‡ Percent. Source of component composition, Tanabian, A., PCB Newsletter, No. 3, July 1971, quoted in Hutzinger, O. et al, op. cit., p. 23. † Percent. Source of component composition, Kuratsune, N., et al., op. cit., p. 1637.

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USES (7,10,12,13,14,16,20,23,25,26)

Polychlorinated biphenyls have a wide application in industry, chiefly owing to their special insulating and water-resistant properties, their chemical stability, and their flame retardance.

Their uses are:

1. Dielectric mediums, capacitor and transformer oils.
2. Impregnants for cotton or asbestos-fiber insulation, as constituents of asphalt-base wire impregnating compounds and as plasticizers in wire-coating compounds.
3. Sealant and expansion media for electrical insulators.
4. Protective coatings for wood, metal and concrete.
5. In combination with di-2-ethylhexyl phthalate, as coplasticizers for polyvinyl chloride compositions.
6. Paint film hardeners.
7. Adhesives composition - in combinations with polyvinyl acetate, ethyl cellulose, chlorinated rubber, polyvinyl butyral, isoprene-styrene copolymer, and polyisobutylene.
8. Lubricants, mineral and vegetable oils.
9. Heat transfer media.
10. Fire-resistant paints, and fiberboard.
11. In moisture proofers.
12. Wood preservers.
13. Caulking compounds.
14. Carbonless-reproducing paper.
15. Paper de-inking processes.
16. In concealers.
17. Solvents for rubber or aniline.
18. Lacquer, varnish, stains, gums, resins, and waxes.
19. Crankcase oil additive.
20. In dyes, inks and pigments.
21. In herbicides and insecticides.
22. In light fixtur
23. [illegible] vertical fluids.
24. In vital fluids for hydraulic, gas turbine and vacuum pump uses.
25. Chlorinated terphenyls, as well as PCBs, are used in some formulations of wax for investment casting processes.

PCBs are employed in capacitors and transformers because they possess attractive dielectric properties [illegible] chemical stability and fire resistance. Approximately [illegible] pounds of PCBs are used in the manufacture of capacitors. [illegible] manufacture of transformers.

More than 95 percent of all power capacitors contain PCBs. [illegible] applications are use on electric utility lines, in air conditioners, and in the ballast of fluorescent lamp fixtures. Approximately 5% of transformers are PCB filled and each of the transformers so filled contains between 40 and 500 gallons of PCBs (about 235 gallons is average).

Capacitors used in lighting and air conditioning applications contain 0.005 to 0.09 gallons of PCB per unit. The largest power capacitors contain about 6.7 gallons of PCBs.

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Beginning in 1971, the Monsanto Company voluntarily restricted its domestic sales of PCBs to closed system dielectric applications in capacitors and transformers.

HEALTH HAZARDS (3,5,6,12,13,14,16,18,20,21,22,24,26)

The health hazards of the polychlorinated biphenyls have been known for many years. PCBs are poorly metabolized and tend to accumulate in animal tissues, including humans. The accumulation, particularly in tissues and organs rich in lipids, appears to be higher in the case of penta and more highly chlorinated biphenyls.

Exposure to the chlorobiphenyls can result in both local and systemic effects. The routes of entry into the body can be through inhalation of the fume or vapor, percutaneous absorption of the liquid or ingestion.

The local effects from a prolonged skin contact with the fume or liquid are skin eruptions (such as comedones, sebaceous cysts and pustules, known as chloracne), pigmentation of the skin and nails, excessive eye discharge, swelling of eyelids, and distinctive hair follicles.

Acute or chronic exposure can produce varying degrees of liver damage depending on the amount of chlorine in the compound and the pre-existing state of the liver. Symptoms include jaundice, anorexia, nausea, indigestion, abdominal pains, and edema. Death from acute yellow atrophy of the liver has also occurred.

In addition, PCB has been placed on the "List of Suspected Carcinogens (1975)" (A Subfile of the NIOSH Toxic Substances List). It is estimated, by NIOSH, that approximately 12,000 people are exposed on their jobs to PCBs, which are used chiefly in the production of capacitors and transformers.

The literature cites numerous reports of cases of liver exposures to polychlorinated biphenyls. Among these are the following:

1. Meigs, et. al., noted seven cases of mild to moderate chloracne among 14 clerical workers exposed intermittently to small concentrations of the vapor of Aroclor [illegible] This substance [illegible] skin of [illegible]

[illegible] may pass [illegible]

3. [illegible]

[illegible] hepatitis.

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outbreak of poisoning in Japan "Yusho disease" that involved 1,291 people (as of April 30, 1976), who ingested PCB contaminated rice bran oil for a period of several months. The contamination of the oil (estimated 1,500 to 2,000 ppm) occurred when heat transfer pipes (containing PCBs), immersed in the oil during processing, developed pinsized holes. The chemical aspects of the poisoning included fatigue, headaches, pain in joints, anemia, chloracne, brown pigmentation of the skin and nails, distinctive hair follicles, increased eye discharge, swelling of eyelids, transient visual disturbances, and vomiting with systemic gastrointestinal symptons and jaundice. In some patients, symptoms persisted three years after PCB exposure was discontinued. Infants born to poisoned mothers had decreased birth weights, abnormal eye discharges, and showed skin discoloration due to PCB placental passage. Two stillbirths to PCB exposed women were also reported. The latency period between ingestion of the oil and the onset of clinical signs and symptoms were generally found to be from 3-5 months.

In addition, there are many reports in the literature describing animal experiments performed using polychlorinated biphenyls.

1. In a monkey study by Allen, six adult female rhesus monkeys were fed the PCB Aroclor 1248 at a level of 25 ppm for 2 months. Facial edema alopacia, and acne developed within 1 month, and one animal died as a result of PCB intoxication 2 months after removal from the experimental diet. In addition to the above changes, this animal had anemia, hypoproteinemia, severe hypertrophia, hyperplastic gastritis and bone marrow hypoplasia.

2. In a rat study, Bruckner observed upon administration of high doses of PCBs, major toxic signs which included diarrhea, chromodacryorrhea, loss of body weight, unusual stance and gait, lack of response to pain stimuli, and terminal ataxia. Progressive dehydration and central nervous system depression appeared to be contributing factors in rat lethality. Histopathologic alterations were evident only in the liver and kidneys.

3. PCBs have also caused liver cancers and reproductive failures in laboratory animals.

4. PCBs have produced various reproductive effects in [illegible]. Table [illegible] summarizes these effects.

Toxicological studies of PCBs are complicated by the [illegible] that the [illegible] of mixtures of many isomers with potentially different toxicities. Studies have been further complicated by the recent discovery that two batches of commercial PCBs (manufactured in France and Germany) contained highly toxic contaminants, almost certainly chlorinated dibenzofurans (CDFs).

Another factor that must be considered in assessing the hazard potential of PCBs is the toxicity of the gases arising from [illegible] which break down PCBs to liberate large [illegible] of highly toxic [illegible] gases. The following are the [illegible] gases [illegible] a PCB [illegible] fire.

GAS	AMOUNT
Carbon Monoxide	0.3%
Carbon Dioxide	9.3
Oxygen	0.6
Inert Gases	1.5
Hydrogen Chloride	97.3
	100.0

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Threshold Limit Value

Both the Threshold Limit Value (TLV)(1975), published by the American Conference of Governmental Hygienists, and the Time-Weighted Average (TWA)(1975), adopted by the Occupational Safety and Health Administration, are the same value. They are as follows:

Chlorodiphenyl (42% Chlorine) - "Skin" - TLV = 1mg/M3
TWA = 1mg/M3
Chlorodiphenyl (54% Chlorine) - "Skin" - TLV = 0.5mg/M3
TWA = 0.5mg/M3

PRODUCT AND PUBLIC LIABILITY HAZARDS (5,10,16,20,24,25,26)

The most noteworthy case of PCB poisoning occurred in Japan in 1968, when quantities of rice oil became contaminated by PCBs that leaked from a heat exchanger. An epidemic of "rice oil disease" occurred.

Kyushu University of Japan reported on recent medical observations made on 1,291 rice oil disease patients who were still suffering more than seven years after their exposure. PCB levels in tissues have fallen to nearly the level in the normal population, and skin conditions have improved, but half the patients still complained of subjective symptoms, which appeared to have itensified.

Other accidents have occurred which involved the direct contamination of animal feeds, which, in turn, caused human food to become contaminated.

Poultry and eggs have been contaminated as a result of the leakage of PCB heat transfer fluid during the pasteurization of fish meal (poultry feed component). (East Coast Terminal Incident; Wilmington, North Carolina, 1971-7/71).

PCB residues [illegible] have resulted [illegible] the use of PCB [illegible] and grain [illegible] of [illegible]

[illegible]

Wildlife Incidents

The [illegible] for [illegible] for Fish [illegible]

The Food [illegible] tolerances for PCBs in Foods (Food [illegible] 1973). The [illegible] are as follows:

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FDA PERMANENT TOLERANCES FOR PCB RESIDUES

FOOD	TOLERANCE*
Milk	2.5ppm (fat basis)
Dairy Products	2.5ppm (fat basis)
Poultry	5ppm (fat basis)
Eggs	0.5ppm (fat basis)
Complete Animal Feeds	0.2ppm
Animal Feed Components (including fish meal)	2ppm
Fish	5ppm (Edible portion)
Infant and Junior Food	0.2ppm
Food-Packaging Materials	10ppm

*The tolerance levels will be periodically reviewed by FDA and adjustments will be made where necessary.

The major source of exposure to the general public to PCBs appears to be by ingestion of fish in the diet contaminated with PCBs.

Recently, reports have discussed the water pollution problems that have arisen from the discharge of PCB contaminated wastes into waterways, e.g. Hudson River and Lake Ontario. It has been reported that striped bass from the Hudson River and salmon from Lake Ontario contained dangerously high levels of PCBs (levels in excess of 5 ppm) and as a result consumers were warned not to eat these fish. The main problem is that PCB does not readily degrade. It persists and, if discarded in the environment in sufficient volumes, a gradual accumulation in certain ecological systems could result.

BOILER AND MACHINERY MAINTENANCE

Damage to boilers and machinery may occur if PCBs are exposed to moisture, in which case, hydrolysis occurs, or at elevated temperatures. In either case, hydrogen chloride gas or hydrochloric acid forms which is corrosive to iron and many other metals.

SPECIFICATIONS (21,23,24)

Chlorinated biphenyls as defined by IEEE, ASTM and the National Electrical Code labeled Askarels generally describes a broad class of fire-retardant synthetic, chlorinated hydrocarbon insulating liquids widely used in transformers, reactors and accessory equipment operated at power frequencies. Under arcing conditions the gases produced, while consisting of predominantly non-flammable hydrogen chloride, can support combustion when mixed with sufficient air.

PCB manufacturers have developed various askarels of different chemical compositions which vary in degree to lower its fire resistance.

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TABLE IV

REPRODUCTIVE EFFECTS OF PCBs IN ANIMALS

PCB MIXTURE	ANIMAL	ROUTE OF ADMINISTRATION	EFFECTS
Aroclor 1242 Aroclor 1254 Aroclor 1260	Chickens	Feeding	Aroclor 1242 and 1254 reduced egg production and hatchability and caused thin eggshells. Aroclor 1260 reduced no harmful effects.
Aroclor 1254	Mallards Bobwhites	Feeding	No adverse effects.
Aroclor 1254	Pheasant	Feeding	Reduced egg production and hatchability.
Aroclor 1254	Mink	Feeding	Severely affected reproduction.
Aroclor 1248	Female	Feeding	Reduced ability to become pregnant. Pregnancies produced small infants with PCBs in tissues.

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Underwriters Laboratories has performed flammability tests on some Aroclors (PCBs) and compared them to other materials. The following are listed:

FLUID	FLAMMABILITY RATING
Ether	100
Gasoline	90-100
Ethyl Alcohol	60- 70
Kerosene (100°F.P.)	30- 40
Mineral Oil	10- 20
*Aroclor 1242,1254 & 1016	2- 3

*(Aroclor is a trademark of Monsanto Company)

An increase in the fire hazard of the PCBs can occur when they are in the form of a mist or atomized droplets. Such a condition could exist when a leak or a pin sized-hole develops in a closed-system containing PCBs; i.e., heat exchangers, hydraulic systems, etc.

CONTROL MEASURES (1,14,19,24)

Manufacturing equipment and operating procedures should be safeguarded against loss of PCBs to the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joinings, valves, containers, and processing chambers should be used for any portion of the operation where PCB temperatures may exceed 55°C(131°F). Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all PCB processing areas to guard against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

To avoid leakage of PCBs the drums used should be of heavy construction; sixteen gauge metal should be used, with special rim seal and bung construction. The drums should be drained as completely as possible and then flushed twice with a kerosene type solvent to remove all PCB. The rinsings should be collected and should be incinerated at high temperature (not less than 2000°F, to destroy the polychlorinated biphenyls.

Conditioning of new PCBs or recycled PCBs is the use of fuller's earth. The spent fuller's earth, in cartridges or bags, when replaced should be allowed to drain thoroughly over drip pans to remove as much liquid PCB as possible. The cartridge units, of steel mesh construction should be placed in the "Steel Contaminated with PCB" container for disposition. Cloth bags filled with fuller's earth should be placed in the "Scrap Burnable Waste" container for disposition.

If a unit has arced so that the PCB material is no longer fit for use, a thorough cleaning of the unit by rinsing with refined kerosene or other suitable solvent and refilling it to service may be a cost saving practice in lieu of liquid disposal.

Because of the problems associated with the health hazards and the disposal of PCBs, much work has been devoted to the substitution of a safer material for transformer and capacitor use. Among those materials being studied are:

1. Diisononyl Phthalate - Exxon Chemical
2. Dichlorobiphenyl plus its alkyl derivative - France's Prodelec S.A.
3. Polydimethyl Siloxane - Dow Corning
4. Butylated Monochlorodiphenyl Oxide - Dow Chemical & McGraw Edison.

Personal Protective Equipment:

Because of the health hazards associated with PCBs, personal protective equipment, including skin protection and respirators, should be worn by all those who come into contact with the chemical. Operating procedures should be such as to minimize or eliminate contact with PCBs. Use of eye protection is recommended. The use of porous gloves that can absorb and retain PCBs is to be avoided.

Safety glasses with side shields or a face shield should be worn when handling PCBs.

It should be stressed to workers that hands should be washed with warm water and soap before eating, drinking, smoking, or using toilet facilities.

STORAGE AND SHIPPING (2,14,24)

Storage

In storing polychlorinated biphenyls take every precaution to guard the PCB from exposure to high humidity and moisture contamination. Keep all storage drums of PCB dry; lay stored drums on their sides with the bung at the highest point from floor to keep water off the drum head (which can be sucked into the PCB by the drum "breathing"). This precaution is not necessary when drums are stored indoors, which is the preferred place for storage.

Impurities such as acids or alkalies also detract from the strength of PCBs.

Shipping

The liquid polychlorinated biphenyls are packed and shipped in galvanized steel drums or in tank cars constructed of nonrusting metals such as aluminum or tin-coated metal. The resinous products are packed and shipped in open-top galvanized-steel drums and the high-melting solid products are packed for shipment in bags.

[illegible]

HAZARDOUS PROCEDURES AND OPERATIONS (1,24)

The hazard in handling the PCBs is the possibility of a spill. Spills of PCBs should be removed promptly by means of absorptive material, such as sawdust, or trapped and removed by pumping or other suitable means.

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Wiper rags, clothing, and other extraneous materials saturated with PCBs should be collected within the containment area for properly controlled disposal.

DETECTION AND DETERMINATION (1)

Air Sampling

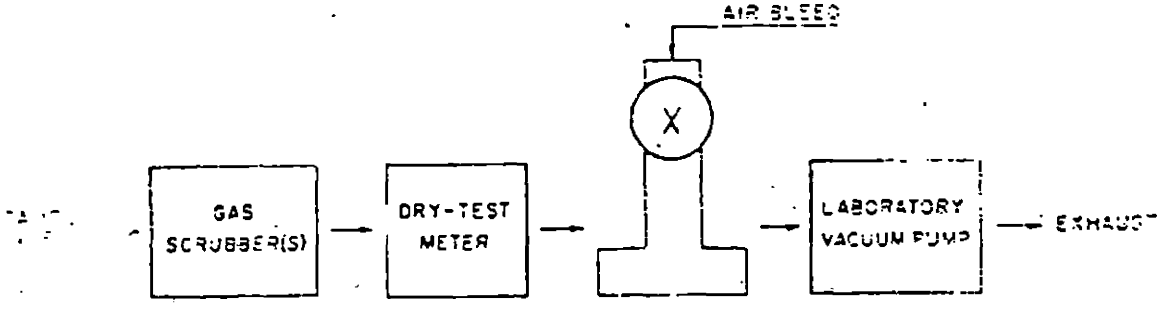
Principle:

Airborne PCBs are absorbed in toluene by drawing the air through one or more fritted bubblers or impingers in cylinders filled with toluene. After a suitable amount of air is sampled, the scrubbing solvent is diluted or concentrated, and interfering components, if present, are removed by chemical treatment and column absorption chromatography. The amount and type of PCBs present are determined by electron capture gas chromatography (EC/GC).

Sampling:

The air to be sampled for airborne PCBs is drawn through a gas scrubber (or scrubbers) and a flow measuring device using a laboratory vacuum pump. The sampling flow rate is controlled by bleeding in air via a needle valve located between the pump and the meter. (See Figure I)

FIGURE I



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Contamination:

In determining PCBs by electron capture gas chromatography, laboratory sources of contamination can be a major problem. The samples and extracts should never be allowed to come in contact with materials other than glass, TFE-Fluorocarbon, or metal. All laboratory glassware and equipment should be cleaned to ensure against the possibility of contamination.

Water Sampling

Principle:

The PCBs in water and sediment samples are extracted into an organic solvent (usually hexane). Interfering components are then removed from the extracts by chemical treatment and column absorption chromatography. The amount and type of PCBs present are determined by electron capture gas chromatography.

The analytical procedure is similar to that already described.

FIRST-AID (1,7,24)

If skin contact with the PCBs occurs, wash the skin immediately with soap and water. If clothing has been contaminated, remove promptly. Eye contact may result in painful irritation. PCBs in the eyes should be removed by irrigating with water for at least 15 minutes. As with all eye first-aid, refer to a physician.

Ingestion or swallowing of PCBs can occur, but it is not generally regarded as an occupational problem by industry. Should accidental ingestion occur, a physician should be consulted.

Persons developing a skin irritation or respiratory tract irritation while working with PCBs should be placed under the supervision of a physician.

[illegible]

[illegible] There are [illegible] should be considered [illegible]

1. Contaminated [illegible] dielectri[illegible]
2. Liquid PCB fr[illegible] solvent operations or water and detergent type washers.
3. Saturated earth or other absorbent media from filtering operations.
4. Saturated sawdust or other absorptive materials from spills.
5. Saturated filters from vapor-cloud devices and other filters.
6. Saturated wastes (paper, rags, etc.)
7. Saturated, spend gasket materials.
8. PCB-contaminated vacuum pump oils.
9. PCB-contaminated jet vacuum system condensates.

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Method of Disposal:

The ideal approach is to totally isolate all effluent streams that could be contaminated with PCBs during manufacturing and processing processes and prevent them from being discharged from the plant. PCB wastes should never be disposed of through effluent drains or sewers. The utmost care must be excercised to prevent accidental loss of PCBs by these avenues to the environment.

Techniques that can be applied to reduce the PCB content of effluent streams are carbon adsorption, limestone beds, and solvent extraction (e.g., trichloroethylene or acetone). These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

Reclaiming of PCBs is usually feasible only with relatively uncontaminated liquids and should be carried out only if there is virtually no chance of PCB losses to the environment. Present knowledge indicates that proper incineration of liquid wastes containing PCBs must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability and, finally, suitable scrubbers to remove the HCl that will be formed: for example, a 2-second dwell time at 1093°C (2000°F) and 3% excess oxygen in stack gas, or a 1.5-second dwell time at 1482°C (2700°F) and 2% excess oxygen in stack gas. These facilities should meet the applicable requirements of the state in which they are located, and should control effluents within the limits set forth by the locality or state. Open hearth and other incinerators used for municipal refuse incineration are not normally suitable. The relatively low operating temperature of such equipment would only volatilize PCBs and pollute the atmosphere.

All solid wastes that have been saturated with PCBs should be disposed of by the following:

1. The saturated wastes should be placed into leakproof containers and transported to a supervised dry landfill site meeting state requirements. Alternatively, they can be disposed of by incineration in state-approved facilities.

2. Solid absorbents used for spills can be disposed of in a dry landfill site

3. PCB

for disposal

Wastes containing PCB
in a sanitary landfill. The
will understand, when
of a chemical waste

In general, terms for a chemical waste landfill provide adequate long-term protection for the quality of surface and subsurface waters from hazardous waste deposited therein, and against hazards to public health and the environment. Such sites should be located or engineered to avoid direct hydraulic continuity with surface and subsurface waters.

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Encapsulation of wastes in concrete prior to disposal in a sanitary landfill has been used for small quantities of solids or sludges.

There has been some research performed in Canada, where a new strain of bacteria that can break down PCBs in waste water, has been developed. This new method is still in the experimental stage, but shows promise.

Pollution:

The disposal of any of the polychlorinated biphenyls has been one of the major items of concern in the use of this material. The PCBs are fire-resistant, noncorrosive, have high dielectric strength, and chemically they are incredibly stable. This is the point of concern. PCB does not readily degrade. It persists and, if discarded in the environment in sufficient volumes, a gradual accumulation in certain ecological systems can result.

PCBs contaminate the environment from the following:

1. Open burning or incomplete incineration of solid wastes, municipal and industrial.
2. Migration from surface coatings (paints, etc.) and packaging materials into foods and feeds.
3. Municipal and some industrial sewers (PCBs present in treated as well as untreated wastes).
4. Accidental spills or improper wastes disposal practices.
5. Formerly, direct application to the environment as ingredients of pesticides or as carriers for pesticides (such uses of PCBs are now prohibited).
6. Dumping of sewage sludge, municipal and industrial solid waste, and dredge spoil at sea.
7. Sewage sludges disposed of on land.
8. Spills and losses in the manufacturing of either PCBs or PCB-containing fluids.

The PCBs released into the North American environment in the past are still [illegible] cycle with [illegible] in three major compartments in the environment: (a) buried [illegible] (b) attached to sediments in rivers and the Great Lakes; (c) [illegible] the continental shelf. A further substantial quantity [illegible] over the land and sea by aerial fallout and by dispos..

Transfer of PCBs within the environment is expected to take place by the following main routes: a) volatilization, aerial transport of particulates, and fallout; b) leaching from burial [illegible] c) sediment transport in rivers and in shallow seas and d) [illegible] return to the ocean. Figure 3 depicts the possible routes of transport of PCBs into the environment.

EPA has estimated that cumulative [illegible] of PCBs in 1979 are 1.5 billion pounds. An additional 750 million pounds of PCBs produced are still in service. EPA has estimated that less than half the PCBs ever produced (500 million pounds) have entered the environment; of this amount, only about 10 percent (50 million pounds) are estimated to have degraded or been incinerated; 300 million pounds are estimated to be in landfills at this time; 150 million pounds are estimated to be in air, water, soil, and bottom sediments.

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FIG. 2

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Although, at present, the use of PCBs in the U.S. is restricted to "closed" systems, an industrial estimate is that up to 55% of "closed" transformers may not, in reality be closed. One weak point for transformer leaks could be gaskets in the leads. Another could be the oil level viewing glasses that may break on occasion. Old or defective capacitors might be deposited in landfills where they may be broken during the burying process; their PCB content could escape, and could eventually percolate to a stream.

In the United States, 5 ppm remains the allowable limit in the edible portion of fish. The FDA has also promulgated tolerances for PCB residues in other foods. (See Product and Public Liability section).

There presently is no federal regulation which specifies the quantity of PCB allowed in water. There is, however, a Federal Guideline for the Power Generating Industry which states that there should be no PCB emission into the water. There is also a "Recommended Procedures for Disposal" of PCB-containing wastes at industrial facilities, issued by the Environmental Protection Agency (4/1/76).

Currently, polychlorinated biphenyls appears in the Proposed Environmental Protection Agency - Federal Water Pollution Control Act - Designation of Hazardous Substances. The proposed regulation would apply to PCBs in quantities equal to or greater than 1 pound when discharged into the water.

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APPENDIX (1)

ANSI Guide C107.1-1974 lists several facilities and services that are available for the disposal of PCBs. These are the following:

1. Chem-Trol Pollution Services, Inc.
   P.O. Box 200
   1550 Balmer Road
   Model City, N.Y. 14107
   (716-754-8231)

2. Monsanto Company
   800 North Lindbergh Boulevard
   St. Louis, MO 63166
   (314-694-3352)

3. Nuclear Engineering Company
   i) Eastern Division
      P.O. Box 146
      Morehead, KY 40351
      (606-784-6611)
   ii) Disposal Division
      Sheffield, IL 61361
      (815-454-2624)

4. Rollins Environmental Services, Inc.
   i) P.O. Box 2349
      Wilmington, Del. 19899
      (302-658-8451)
   ii) Route 322
      Logan Township
      Bridgeport, N.J. 08014

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Migration of Polychlorinated Biphenyls in Soil Induced by Percolating Water

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The thermal and chemical stability of the polychlorinated biphenyls (PCBs) are clearly responsible for their widespread use in the electrical industry. Unfortunately, many of the environmental concerns about PCBs are attributable to the same properties. Where fire resistance and efficient transmission of electrical energy are important, PCBs are the preferred dielectrical fluid. In fact, the U.S. Government's Interdepartmental Task Force on PCBs, PCBs IN THE ENVIRONMENT (1972), concluded that for closed systems such as transformers and capacitors there are no suitable replacement products for PCBs. Consistent with these conclusions, Monsanto introduced a new PCB product, Aroclor* 1016, containing substantially less of the degradation resistant higher chlorinated isomers, restricted the sales to use in closed systems, and set up a high temperature incinerator for disposal of used fluids. While incineration is an acceptable solution to the disposal of used fluids, it is not feasible for many reasons at this point in time for disposal of PCB impregnated material from transformers and capacitors.

The objective of this study was to produce data which would help evaluate the suitability of landfill disposal of Aroclor 1016 impregnated capacitors. Of prime concern was the rate at which percolating water might leach Aroclor 1016 [illegible] soils

Experiment

The experimental procedure employed consisted of percolating water through a column packed with soil coated with Aroclor 1016 and then monitoring the effluent water for PCBs. The set up used is shown schematically in Figure 1. The columns employed are approximately 2" in diameter by [illegible] and were [illegible]

* Registered trademark of Monsanto Company

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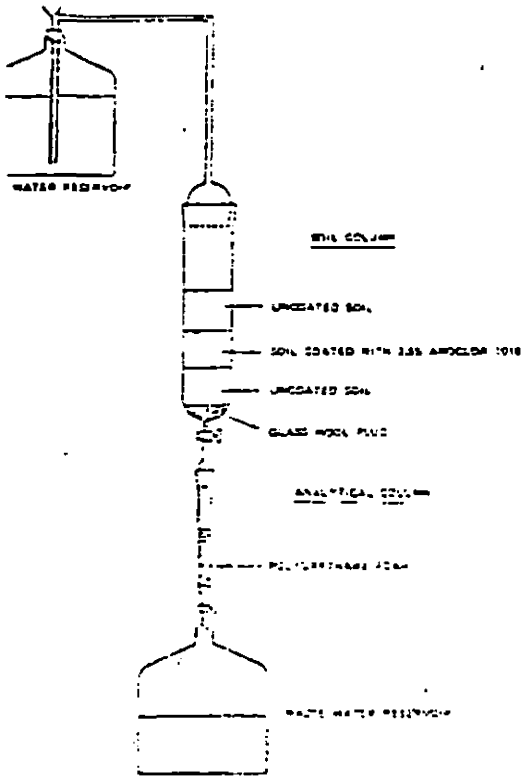


FIGURE 1. SOIL PERCOLATION SETUP

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thick - first uncoated soil, followed by soil coated with 2.5% (w/w) of Aroclor 1016, and finally another layer of uncoated soil. An acetone solution of Aroclor 1016 was used to coat the air dried soil, followed by removal of the acetone in a rotary evaporator.

Three different types of soils were used in this study. The characteristics of each are shown in Table I.

TABLE I

COMPOSITION OF SOILS USED IN STUDY

Soil	Norfolk Sandy Loam	Rey Silty Loam	Drummer Silty Clay Loam
% Sand	82.5	6.2	2.9
% Silt	11.0	83.2	55.4
% Clay	5.5	5.6	35.3
% Organic Carbon	1.0	1.0	6.0

The intent was to simulate the various soil types which might be encountered at different landfill sites. The soils and the procedure employed have been used to evaluate the soil mobility of pesticides and nitrates.

Distilled water was fed from the reservoir at a constant pressure to each soil column. The flow rates were observed to increase the first few days, and then decrease and level out. Apparently, after the wetting phase some channeling occurs until the soil becomes compressed in the column. This effect was most pronounced with the silty soils. The average flow rates in liters per hour for Norfolk, Rey Silty [illegible] and Drummer [illegible] soils, respectively.

The effluent water [illegible] passed through a soil [illegible] tentatively asserts PCB [illegible] carried out in a vertical glass [illegible] polyurethane foam collars for the soil column. In this manner, the effluent could be continuously monitored. The PCBs were recovered from the polyurethane by elution with 50 ml of acetone followed by 100 ml of

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nanograde hexane and collected in a 250 ml separatory funnel. The aqueous phase was discarded and the hexane layer was filtered through anhydrous sodium sulfate into a Kunderna-Danish evaporative concentrator. The hexane concentrate was transferred to an alumina* column and eluted with 125 ml of hexane. The hexane eluent was concentrated in a Kunderna-Danish evaporative concentrator and analyzed using a gas chromatograph equipped with an electron capture detector. The conditions for the gas chromatographic analysis were as follows:

Instrument:	Hewlett-Packard Model 5753A Gas Chromatograph (Ni-63 Electron Capture Detector)
Column:	2M x 4 mm 4% XE-60 silicone on 80/100 Mesh Chromosorb W High Performance - Glass
Injection Port Temperature:	210°C
Column Temperature:	170°C Isothermal
Detector Temperature:	300°C
Carrier Gas:	Helium, 60 ml/min.
Purge Gas:	10% Methane/Argon, 100 ml/min.
Pulse Interval:	50 µsec

Results and Discussion

The polyurethane foam columns were changed and analyzed on days 5, 10, 17, 24, 31, 39, 52, 98 and 118. Table II summarizes the levels of PCBs found in the column effluents.

Breakthrough of the PCBs in the effluent water was related to the clay content of the soil. The soils containing higher levels of clay retarded the PCBs. The order in which breakthrough occurred (as a function of effluent volume was Norfolk Sand, Ray Silty Loam and finally Ottawa

* Alumina, chromatographic grade, 80/200 mesh, activity grade I, was prepared for 4 hours and deactivated with 3% (w/w) distilled water. 30g of alumina packed into a glass chromatographic column 25 cm x 20 mm O.D. topped with 2 cm of anhydrous sodium sulfate and eluted with 75 ml of hexane/ether (96:4) prior to addition of sample.

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TABLE II

PCBs FOUND IN PERCOLATING WATER

Norfolk Sandy Loam		Ray Silty Loam		Drummer Silty Clay Loam	
Total Effluent Volume (l)	ppb PCBs	Total Effluent Volume (l)	ppb PCBs	Total Effluent Volume (l)	ppb PCBs
1.3-8.1	ND	2.7-16.4	ND	1.6-9.9	ND
10.1	ND	20.7	65	12.5	ND
13.5	23	27.6	92	16.6	ND
25.5	63	51.9	153	31.4	ND
48.1	69	98.1	136	59.2	ND

ND = None detected, <1 ppb

(none observed). This is in agreement with recent work, HAQUE (1974), demonstrating that clay has a high affinity for PCBs.

Experimentally, the water solubility of Aroclor 1016 has not been determined; however, it is estimated to be in the range of 225-250 ppb. This estimate is based on the fact that Aroclor 1016 contains more of the less chlorinated, more water soluble isomers than does Aroclor 1242 which has a water solubility of 200 ppb. In all cases, the concentration of PCBs in the effluent water was less than the estimated solubility of Aroclor 1016 in water.

The electron capture chromatograms shown in Figure 2 detail the isomer distribution of the PCBs observed in the effluent water. Aroclor 1242, the product formerly sold for use in capacitors, is shown at the top. The Aroclor 1016 which was sprayed on the soil is shown next, followed by the PCBs [illegible] soils, and finally
Aroclor series, A
standard for quan
peak indicates the
mark. A comparis
1016 chromatograms
ponts and higher chlori
ufacture of Aroclor 1016.

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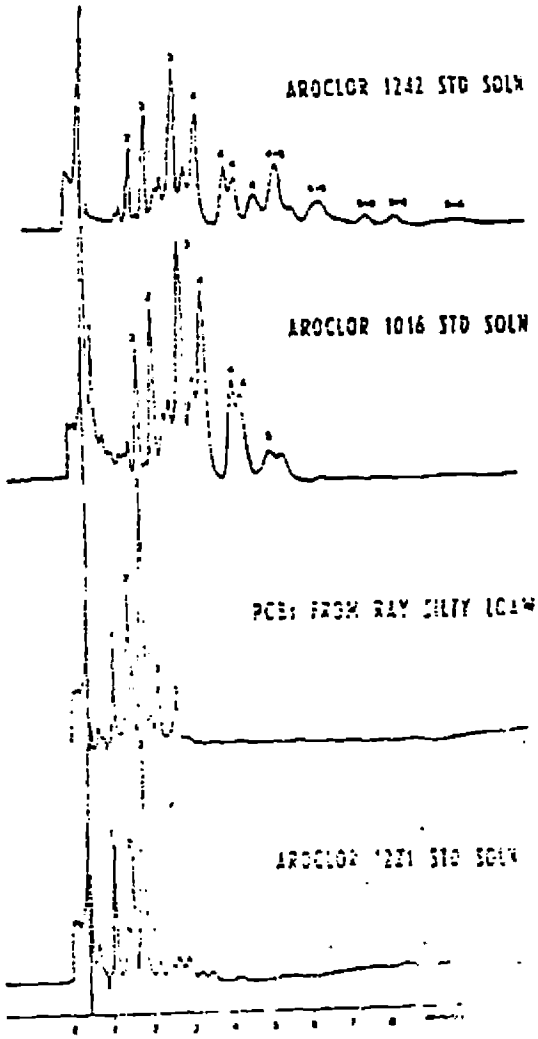


FIGURE 1. PCB ELECTRON CAPTURE GAS CHROMATOG

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The isomer distribution of the PCBs in the effluent water is the result of differences in the water solubility and adsorption characteristics of the isomers in Aroclor 1016. It is evident that only the less chlorinated, more biodegradable PCBs, AHMED and FOCHT (1973a,b), TUCKER (1972), similar to Aroclor 1221, were leached from the soil. A degradation rate for Aroclor 1221 of 75 ± 21% has been observed in semi-continuous activated sludge tests at feed levels of 1 and 5 mgs/24 hours, TUCKER (1972).

Conclusions

The results of this study clearly demonstrate that PCBs are not readily leached from soil by percolating water. In the worst case, less than 0.05% of the total Aroclor 1016 available (25,000 ppm) was leached from the soil during the entire four-month duration of these experiments. During this period of time approximately 50-100 liters of water were passed through the three soil columns, an amount of water roughly equivalent to 50-100 ft. of rainfall, assuming no run off.

The ease of leaching Aroclor 1016 from the different types of soils was in the following order: Norfolk Sandy Loam>Ray Silty Loam>Drummer Silty Clay Loam.

Additionally, it was observed that only the less chlorinated, more degradable homologs were leached from the soils.

The results of this study support the conclusion drawn by the Michigan Water Resources Commission that landfills are only a minor source of PCB environmental contamination, HESSE (1971).

Acknowledgements

The authors wish to thank [illegible]
willing [illegible] soils and his [illegible]
out the [illegible]

References

AHMED, M. and FOCHT, D. D.: Bull. of Environ. Contam. Toxicol. 10, 70 (1973a).

NPC00007469

770108

[illegible]
Indiana District Office
Telephone Call Memorandum

Incoming [X]

Outgoing [ ]

Date: 12-23-75

Time:

FROM	TO
Name: Ray Schneider	D. Stoltenberg
Agency/Company: Monroe Co. Sanitarian	INDO
Address: 211 E. 6th St. Courthouse Annex	
Telephone No: Bloomington, IN 812-332-1721	

SUBJECT: PCB-contaminated Landfills

Message:

Schneider called me to inform of 3 landfills that [illegible] used by Westinghouse for disposal of solid wastes:

1. [illegible] landfill - [illegible]

[illegible]

15 [illegible]

one or two dump truck loads of solid waste per week for a period of 13 months during 1969-70 (ISBH approval of site). wastes [illegible]: metal capacitors containing Inerteen (some leaked); capacitor area was not compacted [illegible]

NPC00007470

770109

From Schneider
12-23-75

2. Neal's Dump — Located in Sec. 33, R2W, T9N (Whitehall Quad.), [redacted] County, just North of IN 1 Hwy. 46. Schneider inspected and saw capacitors in the dump; dump was operated until 1972 when it was closed by court order. A small ditch runs from the dump to Richland Ck; dump encompasses 5-10 acres.

3. Monroe County Landfill — Located in NE¼ NW¼ Sec. 25, T10N, R1[illegible], Bean Tp., Hindostan Quad. (Also called the [illegible] Road Landfill). [illegible] consists of a ditch dug approx. 15 ft. deep by 50 ft. long by 125 ft. wide; [illegible] dumped [illegible]

[illegible] apparently not [illegible]

NPC00007471

Solid Waste Management Section

Notes on PCB Disposal from Westinghouse, Bloomington

Provisional limits for drinking water and soil leachate are set at .05 ppm per the TRW systems report prepared under contract with EPA to do this study report.

From the files:

-There is no record in Solid Waste Management Section files that PCB's were either known or permitted to be disposed at any of the sites.

-There are two references made to land disposal of "Aroclor" (chlorinated phenolic fluid). The October 29, 1968, Industrial Waste letter says that land disposal of PCB's in the Bloomington area is probably not a suitable means of disposal due to geology. PCB-soaked sawdust and filter clay (used to purify PCB's) were known to be going to Neal's Dump immediately west of Bloomington according to Hunt on November 27, 1968.

Sawdust - unknown amount
Filter clay - 40 drums month
Rejected capacitors - 300 pieces month

-The [illegible] site chosen two miles from Stanford, study [illegible], 1/4 mile to [illegible] river, this site predicted to last only two [illegible] years by [illegible]

EPA [illegible] this [illegible]

-The highest levels of PCB's at each of the [illegible] Disposal sites [illegible] the soil analysis.

-Neal's Dump, Owen County, may have to be "recycled" to prevent present future PCB leachate from [illegible] site.

Special Note - The citizens [illegible] Neal's Landfill on S.R. 43 are concerned about PCB levels in Richland Creek which is known for its small mouth bass. Our opinion - levels should not be high enough.

[illegible]

NPC00007472

770111

Monsanto

MONSANTO INDUSTRIAL CHEMICALS CO.
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone 314 694-1000

January 6, 1972

Mr. Carlyle P. Myers
Vice President & General Counsel
Westinghouse Electric Company
3 Gateway Center
Pittsburgh, Pennsylvania 15230

Dear Mr. Myers:

We are writing to advise you that Monsanto has adopted certain restrictive policies with respect to its further sale and delivery of all polychlorinated biphenyl (PCB's) products used as dielectric fluids in transformers and capacitors including but not limited to those sold under tradenames such as Aroclor®, Inerteen®, Pyranol® and under the generic term askarel.

Effective 15 January 1972 Monsanto will sell and deliver these products only to manufacturers of transformers or capacitors who have entered into agreement to indemnify and hold harmless Monsanto in the use of these products and whose financial responsibility [illegible] meaningful [illegible] as appropriate.

[illegible]
may be [illegible]
PCB's have been [illegible]
Because of these [illegible]
discontinue [illegible] sale [illegible]
as dielectric fluids for use in [illegible]
capacitors.

If you have any questions or if you wish to meet with representatives of Monsanto management relative to this agreement, please telephone (314) 694-2455, or write directly to Mr. H. S. Bergen, Monsanto Company, P. O. Box 14617, St. Louis, Missouri 63178. Otherwise, please have the attached two copies of the hold harmless

NPC00007473

770112

agreement signed on behalf of your company by an authorized officer and return one fully signed copy to Monsanto. If we do not receive a signed copy of the agreement in the form attached by 15 January, it may not be possible to sell further quantities of these products to your company.

We sincerely regret any hardships that this decision may cause you but it is taken in an effort to continue to make available these products for critical electrical applications.

Very truly yours,

Howard S. Bergen

Howard Bergen, Director
Specialty Products Group
Monsanto Industrial Chemical Co.

/ff

Enclosures

NPC00007474

770113

DRAFT - For ANSI C 107 Review 1/17/72

Guidelines for Handling and Disposal of Capacitor Drugs Askarels

I. Introduction

The environmental effects of askarels are under in-depth studies by governmental and other agencies. Askarels have been considered non-toxic based on about forty years of safe industrial usage. There has been no known instance of human injury when used under the normally prescribed conditions of precaution and handling.

Askarels are being found in the environment and in fish and birdlife. As stated above, it has been considered non-toxic to humans. However the long term genetic, toxicity and ecological effects are not yet completely understood. For these reasons care should be taken to contain askarels and minimize their entry into the environment.

There are two general types of askarels used by the electrical industry. The liquid dielectrics, which are the more persistent in nature and have a lower degree of biodegradability. Because of their non-flammability, they are used in transformers where personnel safety and reliability are of paramount importance.

Capacitor grade askarel has a lower degree of chlorination, a higher degree of biodegradability, but generally has not been found in animal life. It is used in capacitors where the extreme degree of non-flammability required in transformers is of less importance. The largest consumer uses in the order of 5-6 gallons of askarel contained in hundreds of gallons in larger transformers. Capacitor grade askarel is essentially the 2-chlorine isomer of biphenyl. This isomer of chlorination is found to be more stable chemically and dielectrically than askarels from the higher chlorination fractions, and is most important in getting long capacitor life and reliability. Although capacitor and transformer grade askarels are [illegible] parts of a [illegible] family, they do differ in composition, [illegible] stability, resistance to nature, electrical stability, chemical stability [illegible] of non-flammability. Although both are recognized as non-flammable

II. Capacitor Grade Askarel

Westinghouse has recently introduced a new grade of capacitor askarel, Askarel 1016. The product currently in use is a mixture of trichlorobiphenyl and tetrachlorobiphenyl. This [illegible] is a mixture of these two [illegible] and life, and is [illegible] is not [illegible] this product can still no longer be used in capacitors.

(See Section - Industry Standard on Askarel Composition).

NPC00007475

770114

III. Control of Water Effluents

The industry goal is "zero" concentration of arkawl in plant water effluent streams. However, it is recognized that existing drain systems in expositor manufacturing plants are probably contaminated as a result of past practices, and will continue to show up in effluent streams for some time. Other sections of this Guide provide that no arkawl wastes of any kind be disposed of in any water effluent streams, and that accidental spills be prevented from getting into such streams.

A. Concentration Limits
The maximum allowable concentration of arkawl in water should be 200 parts per billion. On a 24 hours basis, the arkawl content of all plant water effluent streams shall not exceed 2 pounds.

B. Monitoring Requirements
At a rate of not to exceed 1 month intervals, and on a more frequent basis if a plant's particular situation, all effluent streams should be analyzed to determine compliance with the limits in Part A. This can be done by taking a "grab" sample during the day, or a 24 hour composite. The procedures for performing the necessary analyses are described in Section III. Analysis of Water and Effluent For Polychlorinated Biphenyls (or its equivalent) shall be used.

C. Methods for Minimizing Effluent Stream Contamination
The first step is to carefully isolate all effluent streams that could be contaminated with arkawls during manufacturing processes and prevent them from being discharged from the plant. Procedures that could be implemented to this end are as follows:

1. Collect arkawl bearing streams and either by an inserts or centrifugal separation recycle the water phase for reuse and disposal of the arkawl rich phase under the liquid disposal guidelines described in Part II.

2. In all manufacturing areas where arkawl spills can occur, [illegible] floors to an isolated sump where the spills can be securely held [illegible] for disposal.

3. Carbon absorption, ion-exchange beds, or polymeric extraction are techniques which can be applied to reduce the arkawl content from effluent streams. This may be required to meet the limits described in Part A above. This may be necessary if a plant [illegible] arkawl can be picked up in the sewer or [illegible] plant. In most plants all that may be required is [illegible] equipment and [illegible] to monitor the [illegible] of the [illegible] plants.

NPC00007476

770115

III. Control of Water Effluents (continued)

D. Procedure for Water Sampling

Initially all effluent streams from the plant should be sampled to determine baseline values and to identify askarel bearing streams. Hourly samples of the streams should be taken during a typical operating period to ensure the samples are representative of the effluent, or a single sample collected continuously over the operating period. The flow rates of the effluent streams should be measured when the samples are taken. The hourly samples from each stream are then composited in proportion to the flow rate of the stream. Analyses of the composite samples are done in accordance with the procedures outlined in Section IX.

The actual askarel discharge of any effluent can be computed from the quantitative analysis of its composite sample and the mean flow rate of the stream.

IV. Control of Vapor Effluents

[illegible] plant ventilation will carry askarel vapors to the environment. The composition of askarel [illegible] the vapor is expected to be the lower chlorinated fractions of [illegible] which [illegible] the higher vapor pressures (but also have the higher degree of biodegradability).

A. Concentration Limits

The concentration [illegible] any air exhaust stream should not exceed 1 milligram of askarel per cubic meter of air. This is in accordance with [illegible] threshold standards. In addition, the total plant stack emissions shall not exceed 3 pounds per day.

B. Monitoring

The monitoring of appropriate stack effluents shall be done on a periodic basis not to exceed 3-months, and more frequently if required by a local situation. Test Method 73-6 contained in Part IX, Procedure for the Determination of Airborne Polychlorinated Biphenyls (or its equivalent) shall be used.

C. Other Considerations

Large exposed surface areas of Pyranol will be the major [illegible] to any concentration of askarels found in stack effluents, especially if maintained at an elevated temperature. Open containers should be enclosed with vapor tight covers to avoid this.

D. Procedure for [illegible]

[illegible]

From the quantitative determination and with a knowledge of the volumetric flow rate of a given stack, the actual weight of askarel discharge can be computed.

NPC00007477

770116

Monsanto

Monsanto Company
800 N Lindbergh Boulevard
St Louis, Missouri 63166
Phone (314) 694-1000

June 11, 1970

Dear Customer:

In February we advised you of the newspaper and magazine articles indicating that polychlorinated biphenyls (PCBs) have been discovered at some points in some marine, aquatic and wildlife environments and might be environmental contaminants. It was claimed that the PCBs found strongly resembled chlorinated biphenyls containing 54% and 60% chlorine by weight.

Pydraul 625, Pydraul AC, Pydraul AC Winter Grade and Pydraul 540 have historically been formulated with these polychlorinated biphenyls. New formulations have now been developed and tested. These replacement products provide equal or superior performance. The new formulations will be designated Pydraul 625-A, Pydraul AC-A, Pydraul AC-A Winter Grade and Pydraul 540-A. These formulations are completely compatible with the old formulations.

During the next 90 days, as inventory is depleted in warehouses around the country, the new formulations will be shipped to fill your orders. After this period, we will market only the newly formulated products.

We thank you for your consideration in this matter. If we can be of further assistance or answer any questions you might have please contact your local representative who can provide additional technical information about the new formulations or contact me in St. Louis.

Very truly yours,

N. E. Johnson
Marketing Manager
Industrial Fluids

lb

NPC00007478

770117

From Monsanto counsel

March 4, 1969

Mr. W. W. Speicher
Headquarters Industrial Hygiene
Westinghouse Electric Corporation
East Pittsburgh, Pennsylvania 15112

Dear Wilbur:

Enclosed are two copies of material relating to the alleged findings of polychlorinated biphenyls in wildlife. You will recall we discussed this on the phone.

I called Jim Bryant as soon as you and I had finished our conversation. He was trying to reach you in connection with the letter from the attorneys in Phoenix. A copy of that letter is enclosed.

Sincerely,

Elmer P. Wheeler
Manager, Environmental Health

EPW:ejs

Enclosures ----------1. letter from Langerman, Begin and Lewis to Monsanto (Jim Bryant) 2/25/69
2. S. F. Chronicle 2/24/69 "A Menacing Ne Pollutant" - 2 copies
3. "Polychlorinated Biphenyls in the Gl Ecosyst - 2 copies
4. Statements from Monsanto Co. 3/3/69

bcc: P. C. Gorman
D. A. Gisin
W. R. Richard
J. C. Bryant

NPC00007479

770118

Process S [illegible]cification SR-3914CCA

Initial Issue

This specification supercedes the following process specs: 293752, 24[illegible]31, 291180, 1[illegible]31 and 565446. This procedure will eliminate environmental contamination.

Effective Date: 6-11-70

Not to be used after: 6-11-71

/dr

NPC00007480

770119

WESTINGHOUSE ELECTRIC CORPORATION
TRANSFORMER DIVISIONS

Process Specification 89140GA Initial Issue: June 11, 1970

DISPOSITION OF SCRAP INERTEEN AND INERTEEN CONTAMINATED MATERIALS

GENERAL

This specification is written to cover the procedure to be used for disposing of Scrap Inerteen liquid and Inerteen contaminated materials. Used in Sharon

NOTE: Inerteen is primarily a polychlorinated biphenyl, which some studies have shown may be an environmental contaminant, therefore it must be disposed of as indicated.

PROCEDURE

1. Liquid Inerteen

   1.1 Place all scrap or waste Inerteen into drums.

   1.2 Attached "Scrap Inerteen" decals to the drum.

   1.3 Send to Salvage Department for return to Monsanto.

2. Oil Contaminated With Inerteen

   2.1 Place into drums.

   2.2 Attach "Oil for Incineration" decal to the drum.

   2.3 Send to Salvage Department to be diluted and burned in Incinerator.

3. Solvent Contaminated With Inerteen

   3.1 Place into drums.

   3.2 Attach "Solvent for Incinerator" decal to drum.

   3.3 Send to Salvage Department to be diluted and burned in Incinerator.

4. Rags, Paper, Brush and Wood, Blotter Paper Contaminated With Inerteen

   4.1 Place all combustible material [illegible] with Inerteen into [illegible] metal [illegible].

   4.2 When [illegible] full [illegible] Salvage [illegible] Inerteen contaminated materials.

NPC00007481

770120

5. Steel, Copper, Aluminum, Electrical Steel, Glass, Speedi-dri, Filter Cartridges, Etc, Contaminated With Inerteen

5.1 Place all metals and noncombustable materials contaminated with Inerteen into the provided metal containers.

5.2 When containers are full send to area designated for storage of Inerteen contaminated materials.

If any questions covering deposition of Inerteen and materials contaminated with Inerteen contact Materials Engineering Department, Fluid Insulation Section.

NPC00007482

770121

APPROVED _____ _____
Manager of Manufacturing PTD Sharon Date

APPROVED _____ _____
Manager of Manufacturing DTD Sharon Date

APPROVED _____ _____
Manager of Engineering PTD Sharon Date

APPROVED _____ _____
Manager of Engineer Dry type Sharon Date

APPROVED _____ _____
Manager of Engineering UT & E Sharon Date

APPROVED _____ _____
Manager of Materials Engineering Dept. Date

APPROVED _____ _____
Safety Supervisor Sharon Date

NPC00007483

770122

POLICY-PROCEDURE
TRANSFORMER DIVISIONS
LOCATION - [illegible]

[illegible]
NO. [illegible]
PAGE [illegible] OF 1
DATE [illegible]

SUBJECT:

HANDLING AND DISPOSAL OF LIQUID TRANSFO[illegible] WITH [illegible]

PURPOSE:

This procedure establishes methods of handling and [illegible] of Oil and Inerteen liquid dielectrics, as well as [illegible] materials impregnated with these dielectrics, at the [illegible] Boston Plant.

DEPARTMENTS AFFECTED:

Manufacturing
Facilities
Engineering
Safety
Maintenance
Quality Control

RESPONSIBILITY:

Manufacturing

POOR QUALITY ORIGINAL

[illegible]

[illegible] Transformer oil, Inerteen oil [illegible] of 1970.

[illegible] Inerteen liquids, Inerteen filled transformers, [illegible]

[illegible] A PCB Transformer has been [illegible] from a transformer, buffer [illegible] free of combustible to [illegible] fuse.

NPC00007484

770123

SUBJECT:		IDENT	Pg.

RECLAIMABLE INVENTORY: 54201CM which has been returned [illegible] transformer, sufficiently free [illegible] contaminants to allow its reuse.

SCRAP OIL: 15822AG which has been spilled, [illegible] or aged to a degree rendering it unfit reuse.

SCRAP INVENTORY: 54201CM which has been spilled, [illegible] or aged to a degree rendering it unfit reuse.

B. HANDLING OF INCOMING LIQUID DIELECTRICS

Tank cars of incoming Transformer Oil and Inert [illegible] to be handled in the manner prescribed below:

1. The local railroad agent will notify the Receiving Floor when an Oil or Inertene car is located on the utility siding.

2. The Receiving Floor will fill out a Receiving [illegible] notify Quality Control.

3. Quality Control will sample the material to determine whether it meets specifications.

4. If the material passes specifications, Quality Control will notify Maintenance [illegible] are ready for [illegible]

[illegible], Quality and Maintenance

[illegible]

[illegible] with [illegible] heavy [illegible] mineral or [illegible] drying, must be [illegible] by the Quality Control Department, prior to being returned [illegible] reclaimable. The area Supervisor is responsible for notifying Quality Control

POOR QUALITY ORIGINAL

NPC00007485

SUBJECT: [illegible]	IDENT [illegible]	Pg [illegible]

Transformer oil meeting the following tests is fit for reuse:

NEUTRALIZATION	0.10 MAX
POWER FACTOR	0.10 % MAX
COLOR	0.5 MAX
DIELECTRIC BREAKDOWN VOLTAGE	27 KV MIN

Inerteen meeting the following tests is fit for reuse:

NEUTRALIZATION NUMBER	0.10 MAX
POWER FACTOR	5.0 % MAX
COLOR	0.5 MAX
DIELECTRIC BREAKDOWN VOLTAGE	27 KV MIN

Positions of the return pumps which handle reclaimable transformer Oil and Inerteen are:

AREA	COLUMN LOCATION
ASSEMBLY	[illegible]
ELECTRICAL TEST	B 1.67
LIQUID TEST	A -

These pumps have switches, whose keys are in the possession of the section supervisor. Operating personnel will request the pump be turned on during reclaimable dielectric transfer, presenting the supervisor with an opportunity to observe the hookup being made correctly. Caution should be taken to avoid mixing the two types of liquids or during reusable dielectric [illegible].

NPC00007486

FORM 61-902

770125

D. [illegible]

Scrap materials will be yielded in the area noted in attachment "A".

Transformer Oil and Inerteen which fail to meet the standards of reclaimable dielectrics as determined by the supervisor and/or Quality Control, or have been accidental spilled, must be scrapped. Minor spills which occur in the processing area shall be collected and poured into covered scrap barrels which are color coded and identifie These barrels have been placed in the required areas of sections 10, 53, 55 and 59.

[illegible]	[illegible]	[illegible]
Liquid Trans Scrap [illegible]	(A) Inerteen spills (B) Small quantities of unusable Inerteen from transformers (C) Any waste liquids contaminated with Inerteen	Scrap [illegible] are placed in the area [illegible] ed. full, spills transf to convey to scrap p [illegible] s. S personnel of this are fied by train orientation in unloads [illegible] scrap are s [illegible] with [illegible] from th
Liq [illegible] Scr [illegible]	(A) [illegible] (B) [illegible]	

(C) [illegible]
(D) [illegible]

The [illegible] is responsible for [illegible] this material [illegible] in the buried scrap tanks. When either of the tanks shows a level above 10" (75% capacity) the Purchasing Department shall be notified for sale or approved disposal of the material. Dipstick readings will be made weekly

NPC00007487

and more frequently as the 75% level is approached.

When the liquid in an entire transformer full [illegible] scrap dielectric must be disposed of, the transformer must be conveyed to the scrap pump area, column A [illegible] and hooked to the proper pump. The supervisor unit [illegible] the pump and observes the lockup.

All mixtures of any kind of Oil and Inerteen shall be treated as scrap Inerteen, no matter how small the level of Inerteen contamination.

B. HANDLING SOLID MATERIALS FOULED WITH LIQUID DIELECTRIC

Scrap barrels and special tools for liner insulation, from repair tear-downs, which are color coded and identified for the disposal of solids soaked with Inerteen, are provided in the same areas with the liquid scrap barrels.

When the tear-down bay for [illegible] insulation (soaked with Inerteen [illegible] to be [illegible] and [illegible] into the [illegible]

[illegible] Inerteen [illegible] (1) Inert [illegible] absorbent (2) Inert [illegible] earth

[illegible] supervisor [illegible] from [illegible] used. The [illegible] tactor surveys [illegible] utility room, [illegible] mal [illegible] and cover and drum [illegible] scrap [illegible] [illegible] ment drum [illegible] to the scr[illegible]

will be available at this same location. Maintenance observes daily for drums requiring covering, and notifies Purchasing when a shipment to disposal point is ready.

- General plant trash barrels are to be used to dispose of solid material soaked with transformer oil.

F. SAFETY PRACTICES IN HANDLING ASKAREL DIELECTRICS

Transformer Oil (Reclaimable and Scrap)

This material has no properties that are hazardous to health. Normal precautions should be taken to avoid prolonged contact with skin and eyes. Flush exposed areas with clear water. Soap and water will suffice for skin exposure.

Inerteen (Reclaimable and Scrap)

This material is toxic, and should be treated with the same caution as some of the more common chlorinated oxides. It is hazardous to aquatic systems, and should not be allowed to enter the environment.

If accidentally exposed to [illegible] skin areas well with soap and water. Flush eyes with clear lukewarm water, and report to [illegible]. Rubbing the areas will aggravate irritation. [illegible] dote freely. Personnel working with [illegible] and material soaked with Inerteen in oxidizer areas, as well as operations during tank test [illegible], shall use the following:

Rubber Gloves Stockroom Number GL
Rubber Apron Stockroom Number 29

A plastic face shield shall be worn in ar
Inerteen splashing is anticipated, such a
filling station.

Plastic Face Shield Stockroom Number

A respirator all be worn in areas where
heated for processing and an uncomfortable
odor is noticed, such as in the utility roo
Inerteen processing, during unloading and
ferring heated Inerteen-soaked core/coil as
from the processing ovens in Section 52 to
vacuum chambers, and top welding operations
Inerteen units.

Respirator Stockroom Number 770 019

The Section Supervisor of the area involved is responsible for the procurement of proper use of the protective equipment by operating personnel.

5. REFURBISHING COILS AND/OR CORE-COIL ASSEMBLIES IN THE FIELD

Baking of dielectric-soaked coils and/or core coils after repair shall be conducted in the core-c ovens (52-001) in Bank "A", the four ovens clos the vacuum filling chamber. The dielectric-coils or core-coil assemblies shall be dried for four hours at a maximum temperature of 110°C. No dielectric-soaked or partially soaked coils shall be processed in the roof oven.

FORM 83.002

ATTACHMENT A

OIL AND [illegible] WASTE SOURCES

1.	Utility Room	(A) Spillage, Leaks (B) Heated vapors when processing chamber is opened at end of run
2.	Processing Floor	(A) Spillage, Leaks (B) Untanked Units
3.	Vacuum Tooling Chambers	(A) Spillage, Leaks (B) Run-off from soaked units
4.	Vacuum Fill Chamber	(A) Spillage from Hose Disconnects and accidental opening
5.	Core/Coil Process Ovens	(A) Heated vapors from soaked coils assembled under vacuum (B) Spillage from soaked units
6.	Cover Welding Station	(A) Vapors from Re-welding Touch-up.
7.	Tear-Downs	(A) Segments of sheet Dielectric will not fit in standard 55 gal. drum (B) Small segments of wire

NPC00007491

770130

SUBJECT:	DOCUMENT NO.	Pg
[illegible]	[illegible]	[illegible]

ATTACHMENT B

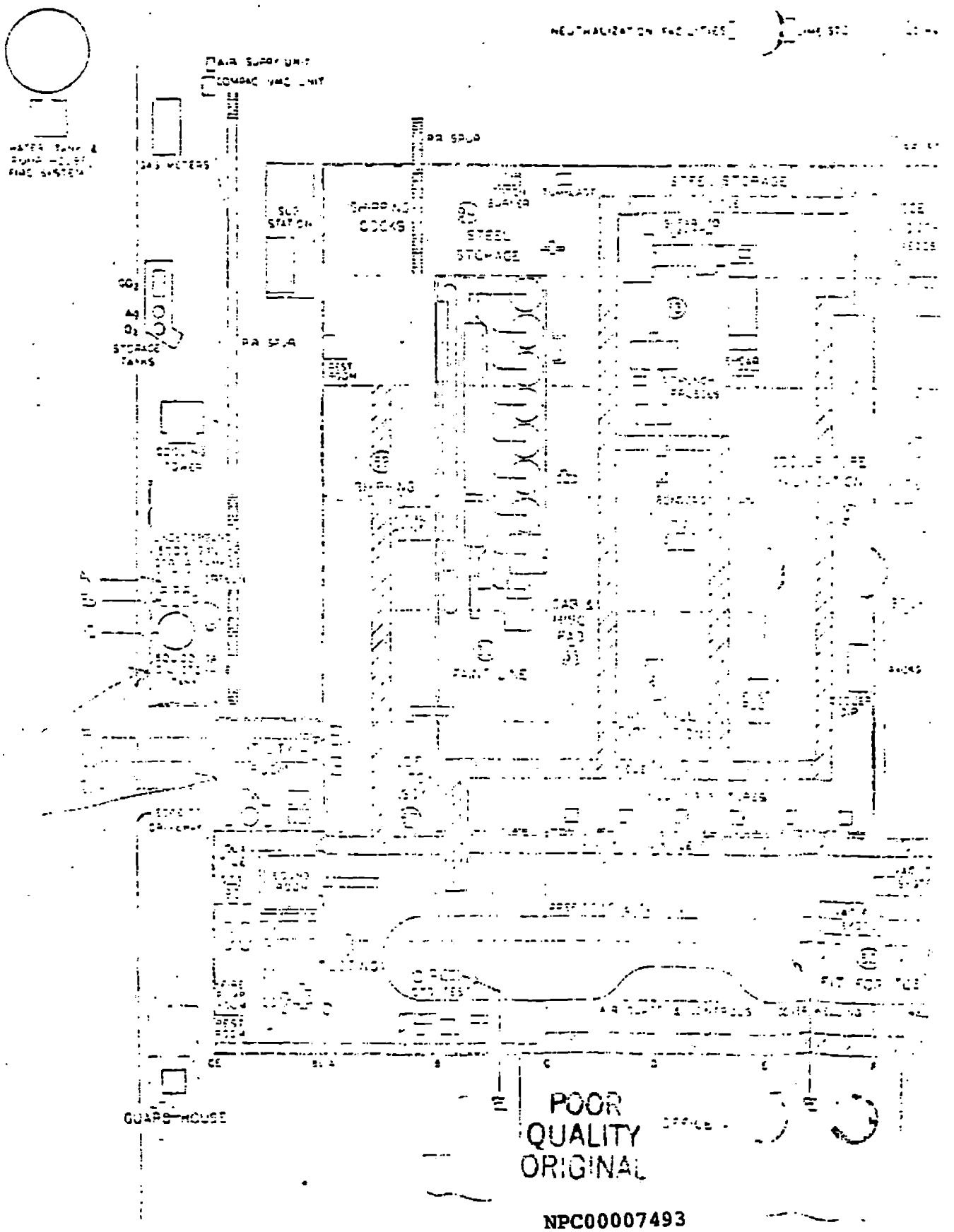
COLOR CODING OF LIQUID HYDRAULIC PLUMBING AND HOSES

Material	Hose At Pumps and Dispensing Points	Background Fill and Return Hose Ends and Plant Piping System	Letter Identification on Hose
OIL	BLACK RUBBER	YELLOW	BLACK -
INHIBITED	[illegible] METAL	BLACK	WHITE-
RECLAIMABLE OIL	BLACK RUBBER	YELLOW	BLACK-
RECLAIMABLE INHIBITED	[illegible] METAL	BLACK	WHITE-
SCRAP OIL	[illegible] RUBBER	GREY	BLACK-
SCRAP INHIBITED	[illegible] METAL	BROWN	BLACK-

NPC00007492

[illegible]

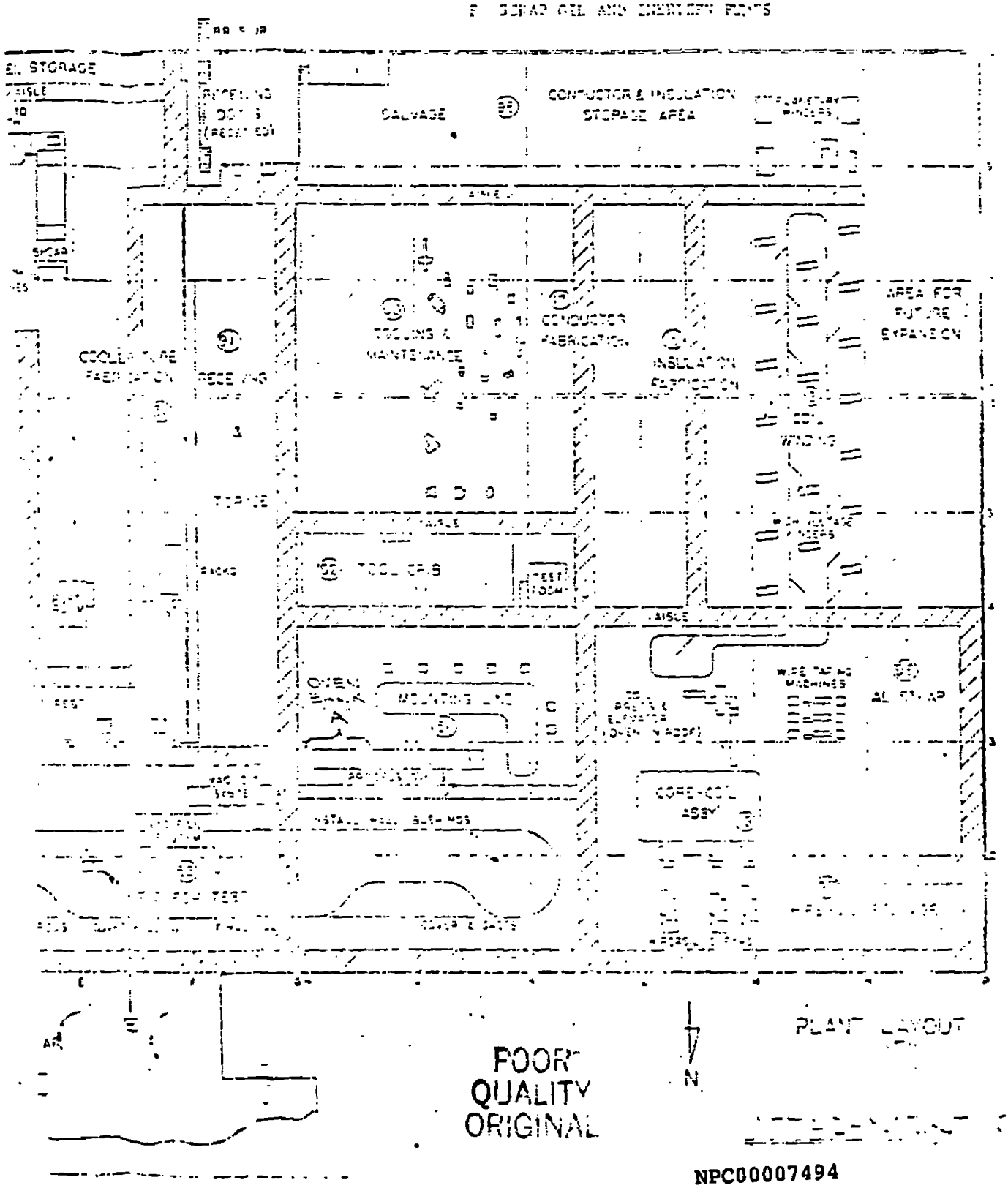
770131



POOR QUALITY ORIGINAL

NPC00007493

A RUBBER SCRAP COLLECTION TANK
B UTILITY SCRAP OIL TANK
C RECLAIMABLE OIL RECEIVING TANK
D RECLAIMABLE CONDUCTOR RETURN TANK
E RECLAIMABLE OIL AND INSULATION BAT'N BINS
F SCRAP OIL AND CHEMICAL BINS



POOR QUALITY ORIGINAL

POOR
QUALITY
ORIGINAL

SUBJECT:

EXHIBITS: ATTACHMENT 1 - Oil & Inert Gas Purge Systems

2 - Plumbing Line Identification

C - Location of Inert Gas Purge
Location of Pump Room
Location of Main and Stripping

PREPARED BY:

Approved By:
Manufacturing Manager

Date

APPROVED BY:

Date

Date

Date

Date

POOR QUALITY ORIGINAL

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POLICY FOR THE USE AND HANDLING OF INERTEEN

I. Introduction

INERTEEN is a synthetic transformer dielectric fluid made by the chlorination of a chemical, biphenyl, to give it non-flammable properties. Since this process stabilizes the fluid for transformer use, it also makes it difficult to destroy when it gets into the environment. Tests have been made throughout the world that show the undesirable nature of this type of fluid and its effect on some species of birds. It can be seen that if INERTEEN is to continue to be used in the transformer, a positive effort must be made to control and prevent pollution by this product.

INERTEEN can get into the environment during the manufacture, delivery, improper use, maintenance, repair and disposal of transformers. Experience has shown that it is necessary to control all aspects of the manufacturing and fluid handling process with emphasis on the possibilities of leakages and spillages to prevent any INERTEEN from getting into the environment. Close attention to good plant house-keeping is the main key to pollution control. Care must also be exercised to ensure that all test samples and INERTEEN contaminated solvents are collected for disposal in an acceptable manner.

Chemicals, such as INERTEEN are not permitted in any effluent from the plant. This is prohibited by the pure stream laws. INERTEEN and INERTEEN contaminated wastes are not acceptable in sanitary land-fills. This then requires that these wastes must be destroyed by incineration.

This problem is extremely serious and will undoubtedly be more closely controlled in the future. By following acceptable procedures the problems of any pollution of the environment by INERTEEN can be controlled.

II. General Safety Precautions

INERTEEN vapor is non-toxic to humans, except if taken internally, but care must be taken to avoid unnecessary contact with the liquid or vapors.

A. Vapors

The odor of INERTEEN [illegible] acceptable air concentrations. The maximum allowable concentration limit (8 hours) recommended is one milligram of INERTEEN per cubic meter of air.

High concentrations of INERTEEN such as found inside a transformer tank or the vapors from hot INERTEEN must be avoided. The high concentrations of vapors can cause irritation of the eyes, nose, throat and upper respiratory tract. If contact with high concentrations of INERTEEN is necessary an approved gas mask or self-contained breathing apparatus must be worn.

The vapors produced when INERTEEN is decomposed by very high temperatures or from an electric arc will consist mainly of hydrogen chloride. This vapor is very unpleasant and irritating, thus giving ample warning of its presence. Under emergency conditions an approved gas mask or self-contained breathing apparatus must be worn in order to enter a space containing vapors of decomposed INERTEEN. If irritating odors are detected with the breathing apparatus in use, the person should go immediately into fresh air.

All gas masks, respirators, replacement cartridges, and self-contained breathing equipment must be Bureau of Mines approved and be maintained on a regular schedule in accordance with the manufacturers recommendation.

B. Fluid

Unlike oil, INERTEEN has virtually no fire hazard. However, INERTEEN can be irritating to the skin. Some people are more allergic to the solvent action of INERTEEN on the skin. Both the liquid and vapor are irritating to the eyes.

Under some conditions approved aprons and gloves should be worn to prevent direct contact with the fluids. The regular use of gloves is not recommended since the gloves are easily contaminated on the inside with INERTEEN from the hands.

After handling INERTEEN the hands should be washed thoroughly with warm soapy water. In the case of spillage onto clothing, the clothing should be removed as soon as practical and laundered or discarded in containers designated as "Scrap Burnable INERTEEN Waste."

C. Eye Protection

INERTEEN and its vapor are irritating to the eyes. Eye protection such as safety glasses with side shields or face shields must be worn at all times while handling INERTEEN.

The use of medical [illegible] to decontaminate skin that has been followed by an application of skin cream will eliminate any irritations resulting from INERTEEN coming in contact with an open cut or abrasion. Eye exposure to liquid INERTEEN should be irrigated immediately with large quantities of water from an approved eye

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wash for fifteen minutes and then examined by the company physician. Persons developing a skin irritation due to contact with INERTEEN should be examined by the company physician.

D. Ingestion of INERTEEN

INERTEEN is moderately toxic if taken internally. Swallowing an ounce or more will cause irritation of the digestive tract and internal reaction. In such cases the person should go to the company physician immediately. Any condition that might result in a possible ingestion of INERTEEN should be avoided.

III. Receiving And Storage Of INERTEEN

INERTEEN is shipped from the manufacturer in tank cars, tank trucks, 55 gallon steel drums and in 5 gallon metal drums. All containers must be labeled as to contents and carry a precautionary label in reference to its environmental hazard. Every container should be inspected for leaks when received.

A. Tank Car Receiving

A special receiving area shall be allocated to INERTEEN tank cars. This area shall have provision for collecting reasonible amounts of INERTEEN if the car is found to be leaking when received. Any leak should be reported immediately to the Superintendent of Maintenance for appropriate action.

Drain pans must be provided to prevent spillage from unloading hoses and connections. INERTEEN tank cars do not have a bottom unloading valve and must be pumped from the top man-hole opening.

Benzene or other approved cleaning fluids used for cleaning the sampling devices must be collected in a "Scrap INERTEEN" drum for disposition. After use the sampling device shall be cleaned, dried and stored in a suitable location.

B. Steel Drums and Cans

On receipt all INERTEEN drums and cans must be carefully inspected for leaks. The containers should be stored indoors in an area especially selected for the purpose. A cement curb should enclose the area to provide a basin for containing the INERTEEN from at least two drums should they be damaged. The area must not have a drain which is connected to a sanitary storm sewer.

C. Storage Tanks

All INERTEEN storage tanks should be erected on a cement base so that inspection can be made for leaks. A wall of cement must be erected around the tank to provide a holding basin to contain all the INERTEEN in the storage tank in the event of a tank failure. The base and wall must be constructed with INERTEEN

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resistant expansion joints to prevent cracking of the cement. A sump drain with pump should be provided to remove any accumulation of surface water but must not be tied into a sanitary or storm sewer. The pump will be manually activated when required. The sump pump must also be of sufficient capacity to pump the INERTEEN from the storage tank basin into containers for salvaging the material or for scrapping in case of a spill. All tank piping must be exposed to permit inspection for leaks.

IV. Plant Manufacturing Area For Filling Units With INERTEEN

It is necessary to assume that in filling equipment with INERTEEN and further handling of this equipment that an INERTEEN spill will occur. Therefore it is necessary to provide facilities and a procedure for clean-up to prevent contamination.

A. INERTEEN Filling Area

The location of the INERTEEN filling area should be adjacent to the test area and final shipping area to minimize the danger of damage of units during handling.

The manufacturing area provided for filling equipment with INERTEEN shall have a cement floor with adequate cement curb around the entire area to act as a basin for containing the volume of INERTEEN from the largest production unit.

Floor drains must not be connected to a sanitary or storm sewer but to a sump provided with a manually activated pump capable of pumping spilled INERTEEN or other liquids into "Scrap INERTEEN" drums.

Adequate ventilation of the area shall be provided to maintain an atmospheric INERTEEN fume level below one milligram of INERTEEN per cubic meter of air. The exhaust from vacuum pump and ventilation of the area shall be directed thru filters capable of removing INERTEEN vapors.

Drip pans shall be provided for hose connections and filling valves.

INERTEEN resistant aprons and gloves shall be available for special operations in which the personnel must come in contact with the INERTEEN.

Respirators, self-contained breathing apparatus, or gas masks of a type approved by the Bureau of Mines must be available for use by personnel in high air concentrations of INERTEEN.

All manufacturing procedures must be directed toward preventing loss of INERTEEN to the environment. In case of an INERTEEN

spill the Superintendent of Maintenance should be contacted immediately to carry out the prescribed clean-up procedure.

3. Special Containers For Scrap Materials

1. Drums labeled "Scrap INERTEEN" must be available for handling all spills and waste INERTEEN from the sump, failed units, drip pans, sample jars etc.

2. Open-head drums with approved closure or other suitable containers labeled "Scrap Burnable INERTEEN Materials" must be available for handling scrap cellulose insulation, rags, paper pressboard, wood, sawdust, etc.

3. Separate containers for handling steel, copper, and aluminum, each adequately marked, shall be provided for the components of contaminated core and coil assemblies when tear downs are necessary.

4. Containers for supplies of saw-dust for absorbing small INERTEEN spills or clean-up must be provided. Speedy-dri or other clay absorbing materials are not recommended.

V. Conditioning of INERTEEN

A. INERTEEN Conditioning Equipment

The conditioning equipment and intermediate storage tank should be located in the bulk storage area which is provided with an adequate curb to contain the INERTEEN held in the intermediate storage tank.

Two alternate procedures are satisfactory. The conditioning equipment and intermediate storage tank may be located in the manufacturing filling area since a curb is provided for containing a spill. If the conditioning equipment and storage tank is located in other areas it must be placed on a cement floor with an adequate curb surrounding the equipment and tank to provide a holding basin for all the INERTEEN in the intermediate storage tank in the event of a tank failure. A sump, not connected to a storm or sanitary sewer, may be provided to clean the holding basin in case of a spill. An alternate would be separate pumping equipment to pump the INERTEEN spill into "Scrap INERTEEN" drums for disposal.

B. Fullers' Earth

Conditioning of INERTEEN requires fullers' earth treatment. The spent fullers' earth in cartridges or bags when replaced shall be allowed to thoroughly drain over drip pans to remove as much liquid INERTEEN as possible. The cartridge units of steel mesh

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construction containing fullers' earth shall be scrapped in the containers marked, "Steel Contaminated With INERTEEN" for disposition. Cloth bags filled with spent fullers' earth shall be disposed of in the containers marked "Scrap Burnable INERTEEN Waste".

The fullers' earth in the conditioning equipment shall be changed when necessary to maintain the INERTEEN within acceptable operating limits.

VI. Tear-Down Of INERTEEN Units For Repair Or Scrap

A. Tear-Down Procedure

1. Drain all the INERTEEN from the transformer from the lower tank valve into the conditioning tank or into drums labeled "Scrap INERTEEN" depending upon the laboratory reports of the condition of the INERTEEN. Allow sufficient time for all the INERTEEN to drain from the core and coil, (at least twelve hours) and again drain the INERTEEN from the tank.

2. Remove the core and coil assembly from the transformer and place it on a steel tear-down table having a raised edge to contain any run-off INERTEEN from the assembly. A center or other properly located drain shall be provided in the steel table to collect the run-off INERTEEN.

3. The personnel that dismantle the unit must wear approved gloves, apron and eye protection.

4. Place all materials in the appropriate salvage containers during the tear-down for later disposition.

5. The tear-down table shall be cleaned with kerosen. or other approved solvents after the dismantling operation. The used fluids shall be placed in the "Scrap INERTEEN" drums for disposition.

VII. Handling Of Empty Containers Contaminated With INERTEEN

A. Tank Cars

When tank cars have been unloaded they will be re-sealed and returned to the manufacturers without further cleaning. These tank cars are used only for INERTEEN shipments and the cleaning will be done by the supplier.

B. Drums

Drums which contained new INERTEEN can be used for waste fluids

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from the INERTEEN manufacturing section and should be plainly marked "Scrap INERTEEN".

Drums which must be retired from use shall be washed twice with one gallon portions of kerosene, benzine, or other approved solvent before crushing, delivery to scrap dealers or used for other disposal. The wash fluid shall be disposed of in drums marked "Scrap INERTEEN".

C. 5-Gallon Drums

5-Gallon drums which contained new INERTEEN when empty shall be washed twice with kerosene, benzine or other approved solvent before scrapping or re-using. The wash solvent shall be placed in a "Scrap INERTEEN" drum.

D. Sample Bottles

Sample bottles and other small containers used for obtaining samples of INERTEEN for test from any source such as transformers, storage tanks, filling lines etc. must be rinsed at least twice with benzine or kerosene before re-use or scrapping. The rinse solvent shall be placed in a "Scrap INERTEEN" drum.

VIII. Purchases of INERTEEN by District Offices and Repair Shops

It is necessary to police the sales of INERTEEN to all users in order to prevent the misuse of INERTEEN by those requiring this material for equipment or applications which are not closed systems thus permitting environmental contamination with the INERTEEN.

A. District Offices

All orders for INERTEEN must be carefully surveyed in order to establish the application for which material will be used. It is desirable, if at all possible, to obtain a service contract to handle the repair or maintenance of the customers' transformer rather than supply the INERTEEN. This assures direct control to prevent the pollution of the environment. For those customers willing to provide a service contract, it is important that the work is performed by personnel knowledgeable in the proper handling of INERTEEN under the newly established guidelines. Orders for INERTEEN for the service contracts shall be placed with Monsanto for delivery to the servicing group and not to the customer.

In those cases in which customers insist on performing their own maintenance and repair work and in locations where service contracts are impractical, orders for INERTEEN will be accepted only after the customer has established the need for the INERTEEN and will provide signed documents indicating they are fully aware of the polychlorinated biphenyl problem, that they have established

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procedures for the proper handling of INERTEEN and that they in no way will hold the Westinghouse Electric Corporation responsible for liability resulting from their use of the INERTEEN. Orders then will be sent to Monsanto for delivery to these customers.

B. Repair Shops

No order for INERTEEN for delivery to any customers will be accepted by the repair shops.

Orders for INERTEEN for service work performed in the repair shops or at customers' location will be directed to Monsanto for shipment of INERTEEN to the repair shop location only.

All repair shops performing service work on INERTEEN transformers must set aside an area in the repair shop to handle all INERTEEN service work. This shop area must be altered to provide the same safeguards as established in the manufacturing locations including curbing around the area to contain an accidental spill, containers for holding materials contaminated with INERTEEN, containers for scrap INERTEEN and safety equipment for employees. All scrap materials must be disposed of at authorized locations that have incinerators capable of safely destroying the INERTEEN.

APPROVED:_____ APPROVED:_____

APPROVED:_____ APPROVED:_____

February 4, 1972

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Monsanto

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

November 30, 1970

Dr. Thomas W. Dakin
Westinghouse Electric Corp.
Research and Development Center
Beulah Road
Pittsburgh, Penn. 15235

Dear Dr. Dakin:

The sale prices for capacitor Aroclor and transformer askarels are being increased two cents per pound effective 1 January 1971. This price increase is necessitated by our higher manufacturing costs and other cost increases due to the PCB environmental problem.

Certain of the more highly chlorinated PCBs (polychlorinated biphenyls) have been found to persist in the environment, and may be harmful to sensitive marine and bird species.

Due to this PCB environmental pollution problem Monsanto has withdrawn certain Aroclors from non-electrical product applications where confinement and control of the PCBs are not possible. This has resulted in substantially lower volumes and increased product costs.

We intend to continue to make these products available to the electrical industry for use in sealed capacitors and transformers. In doing so, the need to conform with requirements dictated by the PCB environmental problem has resulted in additional increases in manufacturing costs, toxicological testing expenses, and research costs.

Monsanto has historically had a responsible pricing policy on Aroclor. We will continue to operate under the same policy and have appropriated this price change as the minimum which would provide Monsanto only the return necessary required by the total increases in our cost of operation.

We solicit your assistance in the proper handling of these products to minimize losses to the environment.

Sincerely,

T. L. Dossage
Director of Sales

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Vendor Copy

Westinghouse

DYNA-VAC Capacitor

Style Number			Serial Number
Kvac	Hertz	Phase	Rated Volts
Kv BIL	Mfd.		Conn.
Contains Dielectric Fluid that and Non-PCB	Minimum Ambient Temperature for Operation		For Operating Instructions Read Inst.

CAUTION

THIS UNIT CONTAINS POLYCHLORINATED BIPHENYL FLUID, WHICH UNDER CERTAIN CONDITIONS MAY ENVIRONMENTAL CONTAMINANT CAUSE INJURY TO HUMAN LIFE AND ENDANGER THE ENVIRONMENT. DISPOSAL SHOULD BE MADE IN ACCORDANCE WITH STATE AND FEDERAL LAWS.

Westinghouse Electric Corporation — Trafford — Made in U.S.A.

NAMEPLATE ASSEMBLY — 1-29-71

.032" THK. STAINLESS STEEL (P.D.S. 71004-H) SATIN FINISH, ETCHED "Westinghouse" & (12) TO BE NATURAL ON BLACK (2) BLDG BACKGROUND.

ALL OTHER LINES, LETTERS & LINES TO BE (2) BLACK ON A NATURAL BACKGROUND.

4 - .125" DIA. HOLES.

3 11/16" BETWEEN CENTERS OF HOLES ON LONG EDGE OF PLATE.

1 7/8" BETWEEN CENTERS OF HOLES ON SHORT EDGE OF PLATE

REDUCE TO 3/4" x 1" FROM 2:1 AREA 0.4 SQ IN.

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APPROVAL

APPROVED BY:

DATE:

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PROPRIETARY CLASS I

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PRELIMINARY REPORT OF INERTEEN ENVIRONMENTAL SURVEY AT BLOOMINGTON DISTRIBUTION APPARATUS PLANT

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PRELIMINARY REPORT OF INERTEEN ENVIRONMENTAL
SURVEY AT BLOOMINGTON DISTRIBUTION APPARATUS PLANT

I. Background

The initial sampling at Bloomington was done in mid-October, 1971 by personnel of the Westinghouse Ocean Research Laboratory and the Westinghouse Environmental Systems Department.

The Bloomington portion of the Inerteen Environmental Survey has as its main objectives to determine if Westinghouse activities in Bloomington have caused readily identifiable leakages of Inerteen (polychlorobiphenyl--PCB) into the environment, and if so, to identify the sources of the material so that a [illegible] program can be [illegible].

As a result of [illegible] at the time of sampling, [illegible] initial. Inerteen [illegible] shipping [illegible] operations [illegible] relocating.

[illegible]

II. Data and Discussion

1. Movement of Inerteen via the Sanitary Sewer.

Until very recently (the last six months), during the manufacturing process capacitor cans were coated on the outside with

-1-

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Insecticide which was removed by a washing process draining directly into the plant's sanitary system. [illegible] waste went into the Bloomington sewage works south of town. Two sewage treatment plants are located about one mile apart with effluents into Clear Creek (it is unclear whether the Westinghouse effluent goes into only one of these plants or both). The possible movement of Insecticide into Clear Creek was disturbing because [illegible] southward 10-11 miles and empties into the Ohio [illegible] the Kickapoo area and Bloomington's source of water is [illegible] taken from [illegible] movement of Insecticide [illegible] tidal [illegible] as the next [illegible] farther [illegible] Minnow [illegible] water [illegible] the [illegible]

[illegible] the Westinghouse plant, this creek was a high [illegible] potential pollution and because it was the object from the sewage treatment plants to serve as a fairly effective biological filter for removing the Insecticide before it reaches the Monroe Reservoir. The creek also appears to have a limited food-chain which does not include fish so that movement of Insecticide from the creek to humans seems rather unlikely.

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Although the level of PCB's is about 50 times above the anticipated background for a clean lake, the fish sample does not reflect this fact. The manner in which the PCB moves into the reservoir from Clear Creek may prevent it from moving up the food-chain. Additional samples should probably be taken, however, to strengthen this point.

2. Movement of Inerteen from Sanitary Landfills.

Three widely separated sanitary landfills have been used for Inerteen disposal and, because each represents a very different situation, they will be discussed separately.

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2.1 Sanitary Landfill Number 1.

During the approximate period 1957-1967, both solid and liquid Inerteen wastes were removed from the plant by an independent contractor for disposal in a sanitary landfill located on a side-hill adjacent to Hiway 48 about three miles west of the plant. Although at that time this procedure was an [illegible] [illegible] been [illegible]

[illegible] the 2.0 ppm [illegible] and 3.0 ppm [illegible] Richland Creek, substantial Inerteen leaches from the [illegible] The samples showed a complex pattern of PCB residues, probably due to biological degradation. A fish (Fish 1A) seined from Richland Creek contained 3.8 ppm of a similar PCB residue pattern.

Two of the samples were rather confusing: an upstream sample on Richland Creek (B26) contained 0.14 ppm Inerteen (about 10 times what one would expect from "background" environmental fallout) and a soil sample (B23) taken on a side-hill across from the landfill contained 0.72 ppm. One possible explanation was aerial fallout from the landfill, and, when inquiries yielded the information that the landfill operator had been cited on several occasions for open burning, additional samples were taken on the hillsides surrounding the landfill in June, 1972.

Figure 3 presents data from these samples taken around the landfill. Although none of the samples is alarmingly high, the samples north and south of the landfill show levels about five times higher than would be expected if aerial fallout had not taken place. Runoff from the slightly contaminated land north of the landfill could easily account for the high value of the upstream sample in Richland Creek. One or [illegible] number of explanations for [illegible]

POOR QUALITY ORIGINAL

[illegible] part of the leaching from this [illegible] the gully runs directly through a farm where animals (pigs and cattle) are being raised. Several years ago, the farmer brought suit against the landfill operator claiming that materials leaching from the landfill were interferring with the reproduction of his cattle. He claimed that his cows

were having fewer calves and that the calves were smaller and less vigorous. The state of Indiana analyzed leachates from the landfill but did not find anything to support the charge (they probably did not look for PCB's). Whether or not PCB's could be causing the farmer's problem is difficult to say without actually sampling his animals, but experiments with laboratory animals have shown that PCB's do interfere with reproduction in the manner described above.

The leaching from this landfill could easily be getting into the human food-chain. Clearly in the case of the farm just below the landfill, PCB's could be contaminating the pigs and cattle. In addition, Richland Creek meanders through many farms where cattle undoubtedly drink from it. Dairy cattle exposed to very low levels of PCB's will produce milk with levels several thousand-fold increased over the amount ingested (contamination of milk is particularly serious because of the very large quantities ingested by small children, and the possibility that the milk ingested may come from the same contaminated sources you

[illegible] landfill (located [illegible] diagram) [illegible] solid waste only. This landfill is located about 13 miles northwest of the plant in a rather remote area.

The data in Figure 4 show that Interteen is leaching from

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this landfill also. B30 was taken from a pile of spoil which had washed down the gully and into the edge of the White River. When one compares the upstream sample on the White River (231, .21 ppm) with the downstream sample (B34, .24 ppm) it becomes clear that, although material is leaching from the landfill, the river is already pretty well contaminated before it passes by the landfill area (as will be discussed later, however, the material could be emanating from the Westinghouse plant).

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At first analysis, the data presented here seemed to clearly indicate that Inerteen contaminated solid waste could not be contained in sanitary landfill as had been asserted by the Monsanto Chemical Company. This landfill appeared to be an ideal test site (unintentionally of course): the landfill seemed well attended, it reportedly had received only Inerteen contaminated solid waste, and it was bounded by gullies sloping down toward a common junction. As it turned out, however, the case was not so simple. The landfill operator was removing capacitor cans from the plant which had not been emptied, and apparently the landfill was only properly covered-over when somebody had arranged to come out for an inspection. The conditions were bad enough that a game warden complained about the oily materials getting into the river from the landfill. Obviously, the data do not accurately reflect upon disposal of Inerteen contaminated solid waste in a sanitary landfill.

2.3 Sanitary Landfill Number 3.

During 1972 a third landfill site was used for disposal of solid waste contaminated with Inerteen. Prior to using the

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site, baseline samples were taken around the area for PCB analysis. These samples all showed traces of very "weathered" PCB residues in the .010-.015 ppm range--typical of areas throughout the country which have only received PCB's from atmospheric fallout.

3. Movement of Inerteen from the Plant.

At the time of sampling the most likely area for movement from the plant appeared to be from the north side of the building where the tank cars delivered the material. All of the drainage from the plant grounds seemed to move northward toward Stout Creek.

The data presented in Figure 5 show the Inerteen levels around the plant. As was expected, all samples contained Inerteen and the area where the tank car comes in is quite high. The B16 sample is much higher than would be expected if this culvert receives drainages only from the other ditches around the plant.

The most surprising samples were those at the south side of the building--B10 at 6,300 ppm is 20-fold higher than the highest [illegible] sample which we had analyzed prior to this program. The [illegible] side of the [illegible]

[illegible] plant [illegible]

B18 [illegible] in Stout Ditch, [illegible] the plant.

Figure 7 shows movement of the Inerteen into the Beanblossom Creek and on into the White River. A fish sample at the junction of

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Stout Creek and Beanblossom Creek showed 5.0 ppm PCB, mostly of the Inerteen formulation (the FDA limit for human consumption in fish is 5.0 ppm).

The samples on the White River indicate that considerable PCB material is being brought down river from some unknown source which cannot be from Westinghouse operations. It is not possible to determine magnitude of the contribution from Westinghouse compared to the amount from the unknown without undertaking a detailed water monitoring program.

Three fish samples taken from a commercial fisherman downstream on the White River (near the Worthington Bridge) indicate that fish from this portion of the river exceed FDA limit for human consumption of 5.0 ppm. Table 1 below presents these data.

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Table 1

	1248 ppm	1254 ppm	Total PCB
Fish			
Fish 2			
Fish 3			

These fish are very definitely transmitting PCB's to humans because we bought dressed fillets prepared for cooking. It would be very difficult to pinpoint the source of the material in the fish, but discovery of these high levels by a regulatory agency could lead to an investigation which would almost certainly discover the leakage of material to the environment from the Bloomington plant.

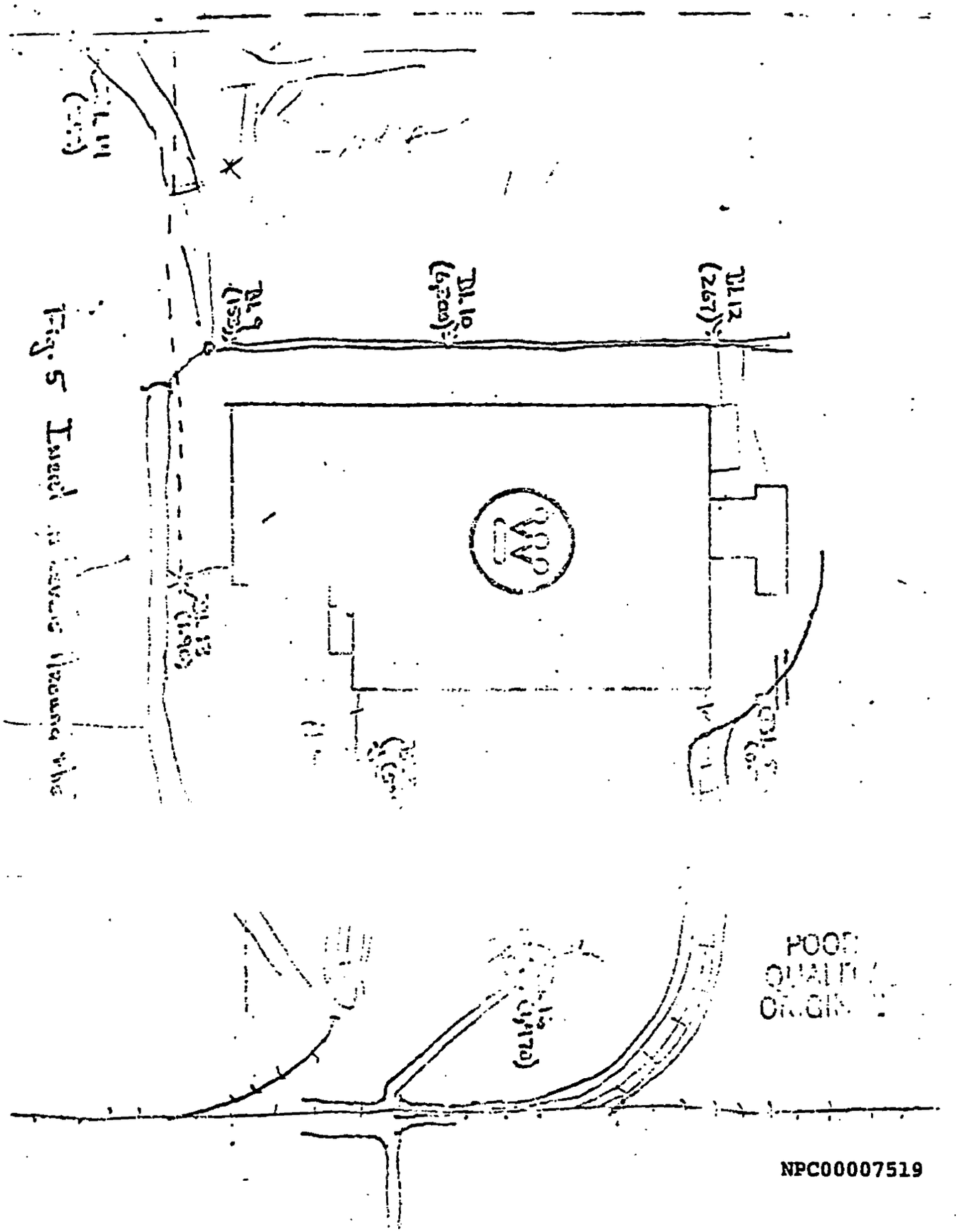
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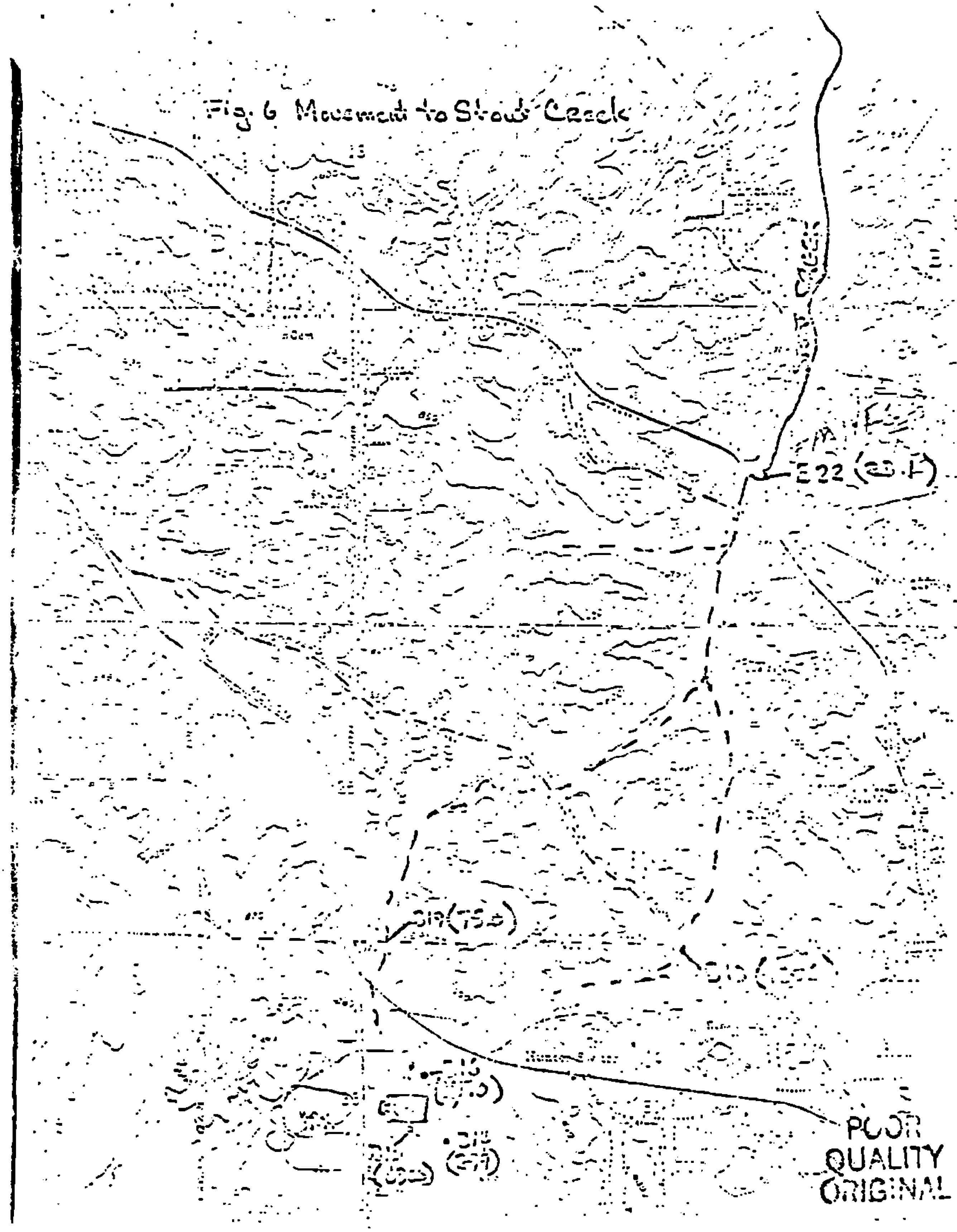
Fig. 7

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770159

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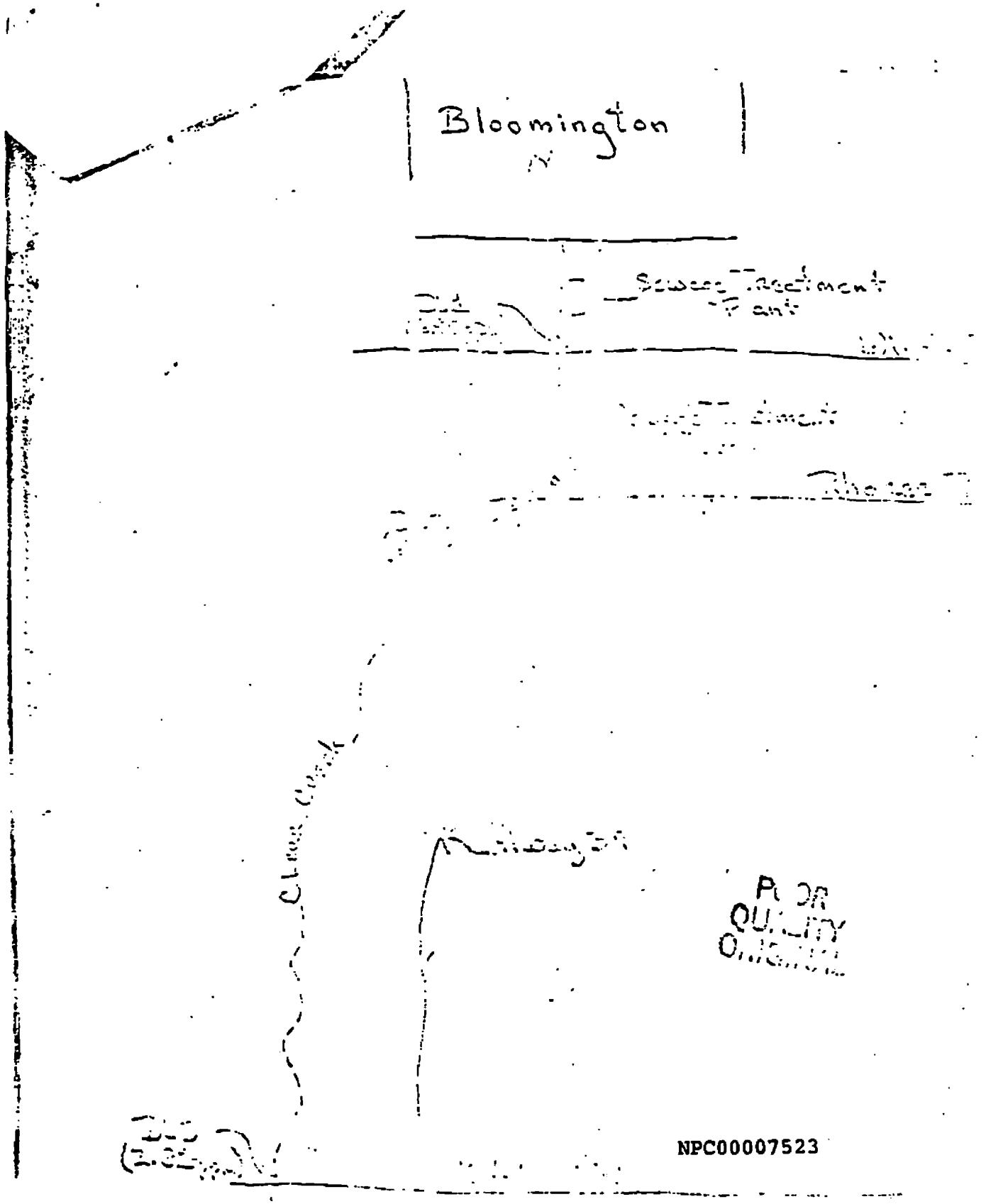
770160

POOR QUALITY ORIGINAL

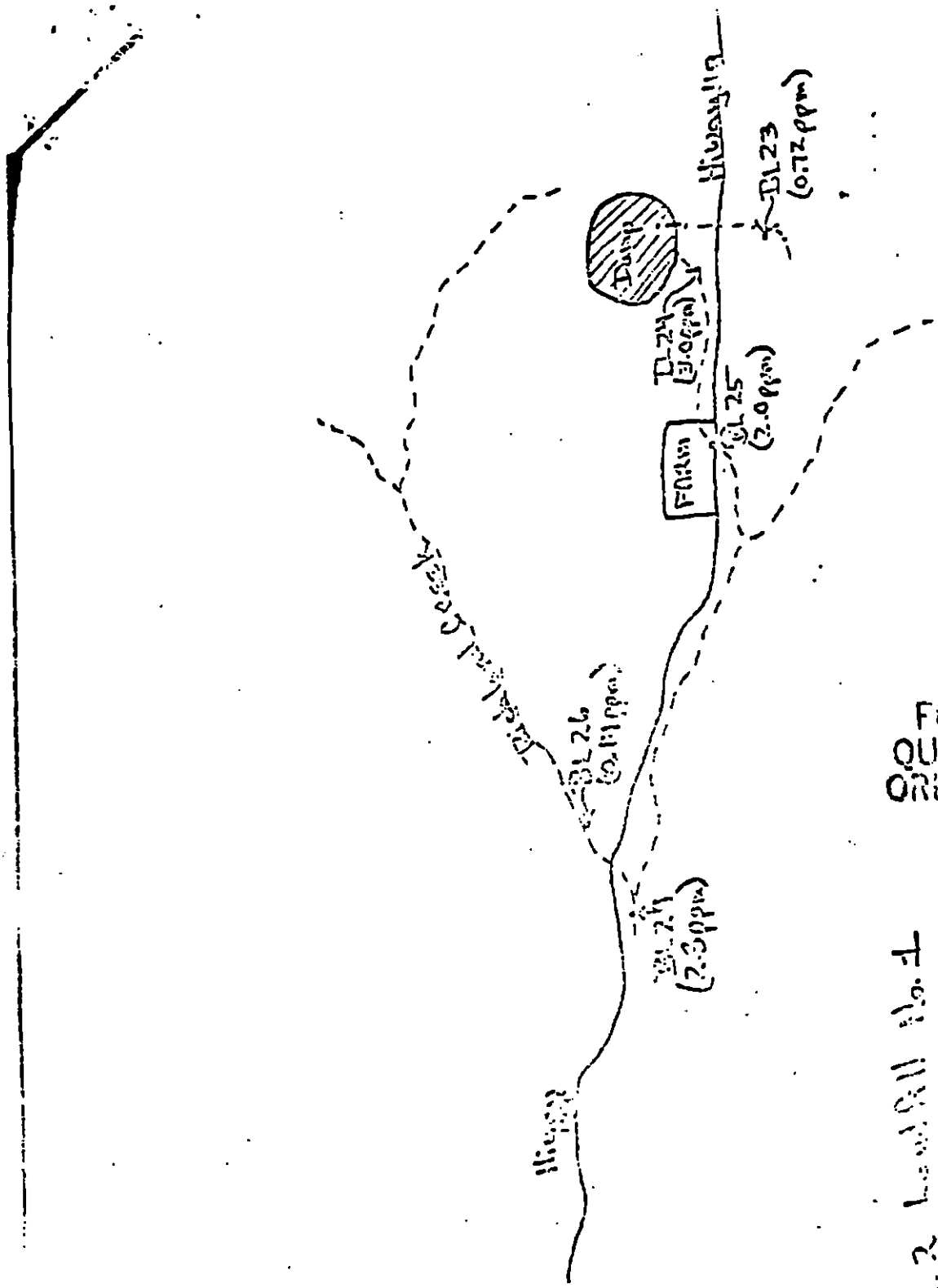
Fig. 1 Landfill No. 2

NPC00007522

770161


Bloomington
Sewage Treatment Plant
Clear Creek
Bloomington
POOR QUALITY ORIGINAL
NPC00007523

770162



FOOR
QUALITY
ORIGINAL

Fig 2 Landfill No. 1

NPC00007524

770163

Westinghouse Electric Corporation

Distribution Apparatus Division Box 341, Bloomington, Indiana

Issued:

P.S. 597078

INTERNAL HANDLING AND CONTROL OF INERTEEN

Note: Inerteen is primarily a polychlorinated biphenyl, which some studies have shown may be an environmental contaminant, therefore the following precautions must be taken.

PROCEDURE:

1. DRAINS: Drains must be eliminated or protected so that no inerteen can get into sewer systems, storm or city.

2. WASHERS: Washers used to remove inerteen must be designed so as to be a closed self contained recirculating system to prevent any inerteen from entering drains, any water from washers containing inerteen must be placed in drums and handled as specified in section 3 of P.S. 597076.

3. FLOORS: A system for containing inerteen must exist and must be adequate to prevent inerteen from getting on the floor.

4. SAWDUST: Sawdust should be used only for application on inerteen resulting from a accidental spill. All spills must be cleaned up immediately and the sawdust disposed of per section 3 of P.S. 597076.

5. CURB: A cement curb should be placed around entire inerteen processing area and should be suitable to contain inerteen and prevent it from getting into drains adjacent to inerteen processing area in case of a leak in inerteen storage tanks.

6. Vapor-Inerteen-Condensers and filtering media must exist on any exhausts that emit inerteen vapors either into the plant or into the atmosphere.

Note: If any questions covering disposition of Inerteen and material contaminated with Inerteen arise contact Materials Engineering.

APPROVED: _____ ACCEPTED: _____
Materials Engineering Mgr. Purchasing

APPROVED: _____ ACCEPTED: _____
Mgr. Capacitor Engrg. Mgr. Quality Cont

ACCEPTED: _____
Supv. Safety

NPC00007525

770164

IN CASE OF LEAK OR SPILL CALL COLLECT [illegible]

CAUTION!

CONTAINS CHLORINATED HYDROCARBONS

Avoid prolonged breathing of vapors or mists.

Avoid contact with eyes or prolonged contact with skin.

If skin contact occurs, remove by washing with soap and water. Following eye contact flush with water.

If clothing becomes soaked with fluid, launder before wearing again.

This product contains polychlorinated biphenyls, which may be present in trace amounts, an environmental contaminant and, possibly injurious to certain forms of land and aquatic animal life. Extreme care should be taken to prevent any entry into the environment through spills, leakage, use, disposal, vaporization or otherwise.

Contact your Monsanto Representative regarding reclamation of used fluid.

WASTE DISPOSAL

Used polychlorinated biphenyl fluids may be returned freight prepaid for proper incineration at 3¢ per pound.

Ship to: Supervisor Dept. A 246
MONSANTO COMPANY
SAUGET, ILLINOIS 62201

NRC0007526

770165

SHARON WORKS - ML-015

Bloomington, Indiana
522-4201
April 1, 1971

Mr. J. C. Rissinger

ANSI Committee on
Use and Disposal
of Askarels

CC: Mr. C. A. Parris, Capacitor Section NEMA

You recently wrote me a letter indicating that the ANSI Committee would be formulated on the use and disposal of askarels. You further stated that representation on this Committee should be by strictly technical personnel with expertise in this field. Also NEMA has been requested to limit its membership to represent companies involved in transformers and capacitors.

Based on your knowledge of the NEMA activities, you are recommending that Dr. T. K. Sloat, Chairman of the Subcommittee in ASTM on Insulating Liquids, be appointed to this ANSI Committee as a representative of that group. By carbon copy of this letter I am recommending to Mr. C. A. Parris that R. D. McClain, Chairman of the NEMA Technical Committee on Capacitors, be one of the three NEMA authorizations. I am recommending that Mr. Parris get in touch with Mr. Salazar to accomplish this,

Askarels are of vital importance to the power capacitor industry. The NEMA Capacitor Section should have strong technical representation on any ANSI work. Mr. McClain, in his capacity as Technical Committee Chairman, will be aware of the work being done by all capacitor companies and can make significant contributions to the progress of ANSI on this important subject.

Would Mr. Parris also please advise the other members of the Capacitor Section of this action after it has been accomplished.

D. M. Sauter
General Manager
Distribution Apparatus Division

cc: J. B. Brittain

John: This letter gets us started on requesting a NEMA space in ANSI. I will leave it up to Don McClain to make sure that Harvey Pickett is included as a representative of this group.

D.M.S.

POOR
QUALITY
ORIGINAL

National Electrical Manufacturers Association
155 East 44th Street • New York, N.Y. 10017 • 212-682-1500

May 4, 1971

File: 11.C107

Messrs. D. E. Allen) Capacitor and
R. D. McClain) Transformer Sections

J. F. Kuzela) Capacitor Section
H. R. Rowe)

W. C. Reinhardt) Transformer Section

Subject: NEMA Representation on ANSI Standards Committee on Disposal of Askarel Used in Electrical Equipment, C107

Gentlemen:

Upon recommendation by the respective Sections indicated above, the Officers of the Codes and Standards Committee, at their April 18, 1971, meeting, appointed you as the personnel who will comprise the NEMA delegation on the new subject ANSI Committee. In addition, Mr. Reinhardt has been designated as Chairman of the NEMA delegation on C107.

For ready reference, the scope and a complete listing of the NEMA delegation on C107 are shown in the attached. In order to help guide you in your work as a NEMA representative, we are enclosing a copy of our "Instructions to NEMA Representatives on Technical Committees of Outside Organizations".

By a copy of this letter, we are notifying all those concerned with this activity of your appointment so that they may note their records accordingly.

Very truly yours,

Bess Fierro

Bess Fierro, Administrative Assistant - Engineering
Engineering and Safety Regulations Department

Attachs.
cc: D. L. Peyton - ANSI
W. B. Papageorge, Chrmn. C107 Comm.
A. M. Salazar, Secy. C107 & TR Sect.
C. A. Parris - CP Sect.
J. J. Kark

NPC00007528

770167

ANSI STANDARDS COMMITTEE ON DISPOSAL OF ASKAREL USED IN ELECTRICAL EQUIPMENT, C107

SCOPE: Procedures and guides for the safe use, maintenance and disposal of askarel and askarel-soaked materials used in electrical equipment.

NEMA DELEGATION:

W. C. Reinhardt, Chairman NEMA Delegation	Central Moloney Transformer Division, Colt Industries P. O. Box 101 St. Louis, Mo. 63166
D. E. Allen	Allis-Chalmers Mfg. Co. Columbus & Preble Aves. Pittsburgh, Pa. 15233
J. F. Kuzela	Sangamo Electric Company P. O. Box 359 Springfield, Ill. 62705
R. D. McClain	Westinghouse Electric Corp. Sharpsville Avenue Sharon, Pa. 16146
H. R. Rowe	McGraw-Edison Power Systems Division P. O. Box 160 So. Milwaukee, Wisc. 53172

5/4/71

NPC00007529

National Electrical Manufacturers Association
155 East 44th Street • New York, N.Y. 10017 • 212-682-1500

May 4, 1971

File: 11.C107

Mr. E. R. Anderson
American National Standards Institute
1430 Broadway
New York, N.Y. 10018

Subject: ANSI Standards Committee on Disposal of Askarel Used in Electrical Equipment, C107

Dear Mr. Anderson:

NEMA, as the Secretariat of the subject new ANSI Committee, wishes to inform that it has appointed the Chairman and the Secretary for the C107 Committee as follows:

Chairman - W. B.Papageorge
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Mo. 63166

Secretary - A. M. Salazar
NEMA Staff

For ready reference, attached is a listing of the personnel who will comprise the NEMA delegation on C107.

Very truly yours,

Bess Fierro

Bess Fierro, Administrative Assistant - Engineering
Engineering and Safety Regulations Department

Encl.
cc: W. B. Papageorge
A. M. Salazar
NEMA Reps. on C107
D. L. Peyton - ANSI
C. A. Parris
J. J. Kark

NPC00007530

770169

National Electrical Manufacturers Association
155 East 44th Street • New York, N.Y. 10017 • 212-682-1500

Joseph F. Miller
President

May 20, 1971

Mr. M. T. Cavanaugh
Managing Director
American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103

Dear Mr. Cavanaugh:

Mr. Salazar has called to my attention your letter of May 13, 1971, in connection with the proposed ANSI Committee C107 on Use and Disposal of Askarel Used in Electrical Equipment. You indicate the most frequently heard criticism of the voluntary consensus standardization program is that it is duplicative, fragmented, and poorly coordinated. While I am sure this is a fairly frequent criticism, I am convinced that one of the real problems with the system is that there are too many organizations who are so jealous of their prerogatives that they devote substantial time and energy to defending their own little kingdoms which time and energy could better be devoted to Standardization efforts.

I note that you quote the scope of Committee C-27, and indicated that you felt the work of the proposed ANSI Committee would be within the scope of the existing ASTM Committee. I feel certain that there are many ASTM committees that have rather broad scopes, some of which no doubt could be interpreted to include areas which NEMA has, for many years, regarded as within the scope of NEMA activity. I can assure you that we have no intention of withdrawing from our activities because of the way the scope of an ASTM Committee is written.

It is also interesting to note that, although you state the proposed ANSI Committee would be duplicative of the work of the ASTM Committee, there is no indication that the ASTM Committee has, in effect, done any work whatsoever in this area. It was the complete failure of ASTM to see that their Committee Chairman was aware of the breadth of the Society's scope which then contributed to this work being channeled toward ANSI by the large users of Askarel and the subsequent formation of the ANSI Committee.

POOR
QUALITY
ORIGINAL

Attachment 3 (6)

It is my understanding, furthermore, that ASTM has two representatives on the ANSI-EETAB which approved the formation of the ANSI Committee. One of the ASTM Committee representatives voted affirmatively on the proposal; the other failed to respond at all. It would have been much more helpful if your official representatives brought your objections to the attention of ANSI while the matter was being discussed before the EETAB rather than waiting until this late date, thereby further delaying a vital program.

Finally, I agree completely with the statement in the third paragraph of your letter that the "problem is one that should be dealt with by our system of voluntary consensus standardization. It affects a large and important industry. It affects government. It affects the general public. It is a problem demanding prompt attention." We in NEMA are well aware of this. We have no real interest in where the work is done. The important thing is that it be done. I regret to note that, as I said before, nowhere in your letter do you state that this work is in fact being done or will be done by the ASTM Committee.

Sincerely yours,

Joseph F. Miller
President

JFM/jr
cc: W. F. Papageorge
D. L. Poyton
H. N. Muller
A. M. Salazar

ATTACHMENT 8 (4)

NPC00007532

August 5, 1971

Mr. Bernard H. Falk
Vice President
Government and Membership Services
National Electrical Manufacturers
Association
155 East 44th Street
New York, New York 10017

Subject: H.R. 10085 and H.R. 8576

Dear Mr. Falk:

In response to your letters of August 2 and June 16, 1971 with regard to legislation introduced by Congressman Ryan prohibiting the use of PCB's, we wish to offer the following comments:

1. Within the broad class of materials categorized as PCB's are included the several askarels extensively employed in the manufacture of transformers and capacitors.

2. Suitable alternative fluids incorporating the safety feature of non-flammability and of economy are not available.

3. More than 30 years experience with controlled manufacture and use of these materials in electrical devices do not support the position that they represent such serious hazards as to require a total ban on their use in all applications.

4. Controlled use of askarels may be favorably compared with numerous examples of widespread, controlled usage of other potentially hazardous materials.

5. The response of the domestic supplier of PCB, Monsanto Chemical Company, in providing a refined askarel with the more highly persistent components removed provides a sound basis for further protection against any prolonged or long term danger that could result from spills, or other inadvertent loss.

6. Action in foreign countries, bringing the usage of askarels under control can serve as a useful guide in domestic action.

We, therefore, feel that NEMA should establish the proper action to put this matter in the proper perspective before the interested groups and persons in Congress. The needs for askarels in power capacitors and the adequate controls already established in our industry, should assure responsible action by Congress and the electrical industry. I believe we can work together for realistic control of PCB material.

We also recommend that NEMA be instrumental in bringing about early action by ANSI-C107 to establish recommended procedures for disposal of waste askarels.

Sincerely,

D. M. Sauter
General Manager
Distribution Apparatus Division

New Folder PCB TASK FORCE file EV Clarke

BUILDING - Transmission & Distribution
Mr. E. V. Clarke, Jr.
Executive Vice President

From SPTD-South Boston
WIN 225-7200
Date October 28, 1976
Subject Retrofitting of PCB-filled Transformers

cc: SHARON - Mr. R. A. Baker, Jr., General Manager
cc: BLOOMINGTON - Mr. D. M. Sauter, General Manager

At the present time certain developments are occurring which I believe deserve our attention relative to the future service and possible "retro-fitting" of transformers now filled with PCB's. Some of these developments are as follows:

(1) Dow Corning's marketing development man, Mr. Tor Orbeck, is calling on many of our customers and attending various industry meetings, promoting silicone fluid and encouraging users who have transformers filled with PCB to consider draining the PCB and refilling with silicone fluid. This would leave about 3% residual PCB. 30,000 ppm of PCB Not satisfactory

(2) These customers are calling us and asking if this can be done. We are telling them that strictly from a technical standpoint we are not sure and, for a fee, we will investigate their design and give them our best advice. The two most critical technical concerns of which we know about now are:

(a) Whether the expansion of the silicone fluid during heavy load (which is significantly greater than the expansion of inerteen) will compress the gas above the fluid level to a pressure greater than the design pressure of the tank. Dow Corning say they have made tests which convince them this is not a problem because while the silicone does expand, it also absorbs the gas sufficiently to offset what would otherwise result in an excessive pressure rise. We are in the process of running tests to verify their claim but it will be several weeks before the tests are completed.

(b) Whether silicone fluid, having different viscosity versus temperature characteristics will, in fact, adequately cool the transformer without derating. Dow Corning has no expertise in this area but we are also running tests to determine whether the cooling characteristics of the silicone fluid would, in fact, be adequate in a retrofit situation. These tests, too, will not be complete for several weeks.

NPC00007535

(3) Once we have the results of the test data we will have a reasonable basis for making a sound engineering recommendation---at least for South Boston designs. For Sharon designs which are now within our charter, we feel it would be best for Sharon to answer the customers for the reasons that we don't have the design data here at South Boston, nor do we have the manpower available to research the design, nor are our engineers as familiar with the Sharon design criteria for purpose of interpreting its adaptability to retrofit as is Sharon engineering. As a matter of policy/procedure this problem needs to be resolved to the best advantage of the business unit.

(4) Meanwhile, there are efforts in progress which, if successful, may at least make it awkward if not impossible to "retrofit" in any event.

(a) You have advised that an EEI committee announced at the last AEIC meeting their recommendation against retrofit.

(b) ANSI C-107 Special Task Force has published a proposed standard upon the strong encouragement of EPA which "recommends" against retrofit, or if retrofit is made, the retrofitted unit must carry a special nameplate indicating it is filled with insulating fluid contaminated with PCB.

(c) Westinghouse has two members on this ANSI C-107 committee, Mr. T. K. Sloat from Sharon and a man from Bloomington. To my knowledge, our two representatives have not been advised by our management how they should direct their efforts in this endeavor with respect to what our management believes is the best course to pursue (i.e. whether retrofit is good or bad) and are therefore pursuing the course that their own professional experience indicates is best. It should be clear I don't honestly know whether it is better to retrofit or not. My point is that I doubt the subject has been carefully studied in all its ramifications and ultimate economic and environmental impact. Instead, we appear to be following the EPA without thinking the problem through ourselves.

d) The ANSI C-107 proposed standard recommending no-retrofit is now out for ballot. It is expected the standard will be approved. When it is approved, we understand EPA will use it as the basis for a proposed rule-making. In due course (perhaps a one year interim) the proposed rule becomes a firm regulation. At that point it will be illegal to retrofit.

(5) There is the problem of normal service for PCB filled units, regardless of how the retrofit matter turns out. Both Bob Baker and I are in complete accord in our objective of keeping any transformers containing PCB out of the manufacturing plants once we finish production of those units now on order. But we recognize our contractual responsibility for repairing units within the warranty period and our commercial responsibility for servicing units which are out of warranty. Normally this

work is done by the Service Divisions within their charter. I talked with Ed Price about this last Friday and he agrees with us but, as you may know better than I, he is faced with unknown problems in trying to work on PCB units in the future and comply with whatever rules and regulations are promulgated by EPA and perhaps by the Department of Transportation, etc. But for planning purposes I feel there needs to be close cooperation between the manufacturing divisions and the service divisions. For the normal repair function he needs to know where he can obtain make-up inerteen when Monsanto ceases to be a supplier. He needs to know how he can "top-off" an inerteen unit if inerteen is not available using trichlorobenzene and/or oil, etc. If retrofitting is pursued he needs to know which units can be retrofitted without derating. His service policies need to be developed in technical and commercial consonance with our business unit and the group or we can get ourselves more tangled up than the government itself.

(6) In the foregoing, I have not even tried to assess the PCB-in-oil problems.

(7) And there is an urgency to developing our strategies and plans because Monsanto has announced a rigid time schedule for their PCB exit. Within three months Westinghouse must place orders for whatever amounts of PCB we may decide we want for the future.

It might be appropriate to consider forming a task group which would work to develop a plan for, and with the full support of, the manufacturing and the service divisions.

- It would develop strategy, plan the tactics and implement appropriate action.
- It would seek to establish a dialogue with EPA, with our customers (most of them are industrial and construction) and perhaps through NEMA with the manufacturing industry-- try to determine what is going to happen and when.
- It would assess what chance we (individually as one manufacturer or collectively as an industry) would have of changing the course of events as they seem to be developing.
- If we believe we can affect the course of events the task group needs to decide what course is best and, if it is deemed worthy, make the effort to cause the change.
- The task group would seem best headed by the marketing function but it needs technical, legal and economic support.

This is not intended to be an erudite or comprehensive exposition of the problems and even less so their solution. But I do believe the problems are real and if we organize properly we may be able to influence what happens in a beneficial way and at least we should be able to avoid making costly errors in our own plans. It seems to me this PCB situation is going to be a real headache for everybody concerned before we are through with it. Our customers and even EPA are looking for help in solving the problems ahead. I think if we take a thoughtful leadership role we can help solve these problems. For instance, by careful, in-depth analysis of the ultimate course of events we can show technically and economically whether retrofit is, or is not, a good thing to do. It is even possible that EPA would pay us for such a study.

John Aldworth

John G. Aldworth

Ref: J. H. Pickett

CP 2104

BLOOMINGTON WORKS

From : Engineering Dept.
WN :
Date : September 11, 1972
Subject :

Mr. D. M. Sauter, Chairman
NEMA Cap. Committee

cc: C. A. Parris

Because I will be attending school, it will not be possible to attend the October 3 meeting of ANSI C-107 at Gaithersburg, Md. Because this meeting of the main committee will consider the recently completed drafts of the "Guidelines for Handling and Disposal of Capacitor and Transformers Grade Askarels Containing Polychlorinated Biphenyls", it is important that an alternate delegate be designated by the NEMA Capacitor Committee.

Accordingly, I recommend that Mr. J. H. Pickett, of Westinghouse D.A.D. be so designated. Mr. Pickett is well acquainted with the proposed guidelines and the various implications of their adoption by the industry, and is entirely competent to serve in this capacity.

Robert D. McClain

R. D. McClain, Chairman
NEMA Tech. Committee, CP-1

RDM:kh

Hawley -
If you haven't received confirmation by Sept 28, let me know.
Don

FORM 3566 U

NPC00007539

770178

Harvey Pickett

Westinghouse Electric Corporation

Distribution Apparatus Division Box 341, Bloomington, Indiana 47401

September 14, 1972

R. D. McClain, Chairman
NEMA Tech. Committee, CP-1

Subject: ANSI C-107
"Guidelines for Handling and Disposal of Capacitor and Transformers Grade Askarels Containing Polychlorinated Diphenyls"

I agree with your recommendation that Mr. J. H. Pickett, of Distribution Apparatus Division be designated as alternate to attend the October 3rd meeting of ANSI C-107, and you should proceed accordingly.

D. M. Sauter

D. M. Sauter, Chairman
NEMA Capacitor Section

cc: C. A. Parris
A. M. Salazar

NPC00007540

770179

Suggested Response to Notice of PCB Spill:

Scope: Establish fast response to notice of major spill of PCB (Aroclor/Inerteen); outline action to notify authorities; indicate methods of containment; establish standard, basic information for use by those concerned; act to minimize costs, liability, loss of material.

A. Incoming notice of spill to be directed to

1) R. D. McClain - (812) 332-4421, Extension 273
or (812) 332-5056 (Home)

2) R. B. Sawyer - (812) 332-4421, Extension 220
or (812) 332-7461 (Home)

3) A. J. Fink - (812) 332-4421, Extension 298
or (812) 332-5775, (Home)

B. Notice of spill will be provided by telephone (by one of the above 3 persons) to the following:

1) Monsanto (618) 271-5835
and Bill Moore, Akron

2) Indiana Stream Pollution Control Board
(317) 633-4420
or (317) 633-5369
or (317) 633-4360 (after hours)

Immediately, whenever possible, notify the nearest downstream water user.

3) E.P.A.

a) If spill is North of U.S. Highway #40,
Chicago (312) 353-6188
or (312) 353-5638

b) If spill is South of U.S.Highway #40,
Evansville (812) 423-6871, Extension 266
[same for Illinois]

4) Illinois

5) Westinghouse

a) Gateway - Roger Wills, Attorney: WIN 8-235-5815
L.D.
Home

Alternate:

NPC00007541

770180

(b) Bloomington - D.A.D.
- D. M. Sauter, Plant Manager - 332-0095
- D. Williams, Manager of Manufacturing -339-0611
- J. Brittain, Manager of Engineering - 332-5622
- J. L. Shoaff, Matls & Stds. Engineer - 876-5207
- G. E. Mercier, Capacitor Engrg. Manager - 336-3880
- N. E. Maguire, Manager of Shipping - 332-7646
- K. Kelly, Purchasing Manager - 332-9666

C. All rail shipments, Sauget, Illinois to Bloomington, are via Illinois Central Railway, over routes indicated on attached map. ("A")

Nearest highway point (town) is circled on attached segment of highway map. ("B" or "C")

Bloomington D.A.D. representative will depart for spill site as soon as possible.

It is understood that the railway will be in charge of wreck salvage. (A booklet from the American Railway Association outlines handling of non-hazardous materials.) Depending on the magnitude of the wreck, one of the following will be in charge:

Large - Superintendent
Medium - Assistant Superintendent
Small - Local Trainmaster ("D")

Assistance to be rendered will be in the nature of providing information as to identification of the material, precautions to be followed, the urgent need to control and contain the spill, and possible means for disposal.

a) Nature of material: See label on car. (Copy attached) ("E") See attached extract from ANSI C-107. See industrial hygiene excerpts from C-107. ("F")

b) CAUTION: DO NOT FLUSH SPILL WITH WATER.

DO NOT INCINERATE OR BURN IN THE OPEN ATMOSPHERE.

EXTINGUISH ANY FLAMES WITH DRY TYPE FIRE EXTINGUISHERS.

c) Contain spills onto open ground with earth dikes or with absorbent material such as OIL DRY, SAND, SAWDUST, etcl, or soil, which can be recollected for future disposal.

Drain off fluid remaining in tank car into sealed drums.

d) Note that fluid is heavier than water and is almost completely insoluble.

Spills into shallow, still water, or slow moving water, may be

NPC00007542

770181

contained with suitable dikes allowing surface clear water to overflow if necessary. Pump or sluice out contaminating fluid from bottom.

e) PCB fluids and contaminated materials may be disposed by placing in sealed drums. Shipment, to disposal site (Monsanto or Chemtrol), will be arranged subsequently.

Visitation to the site by Indiana Stream Control Board Representative should be expected (in Indiana), to review action being taken, and possibly to make suggestions or to offer instructions. (If instructions are not followed, Westinghouse may become liable for the consequences.) ("G")

D. Information to the press: Inquiries from the press or other news media are to be referred to _____.

E. Indiana State Board of Health regulation SPC-16 requires 5 steps to be completed on notice of spill (See excerpt from Indiana Environmental Health Action, attached). Submission of a complete report may be required by the Indiana Stream Pollution Control Board Technical Secretary.

F. Notice of lesser spills may require part, or all, of the actions above:

Possible "medium" spills can result during shipment of waste to Chemtrol for disposal. Such spills can involve other authorities (than Illinois or Indiana).

A card of minimum instructions (similar to that of Monsanto's on the tank car) is to be provided to the driver on each shipment. (See attached). ("H")

G. Spills from apparatus enroute to a customer are likely, but smallest in potential magnitude.

"Spill Control Instructions" attached.

NPC00007543

770182

H/C Claim

April 4, 1972

RECEIVED
APR 10 1972
DEPT. MGRS. OFFICE

Mr. W. H. Ferguson
Engineering Manager, Switchgear Div. - TN
Westinghouse Electric Corporation
East Pittsburgh, Pennsylvania 15112

Subject: Warning Labels

Dear Mr. Ferguson:

As requested by Mr. Sauter in his letter of March 20th to all member companies in the NEMA Capacitor Section, we are giving you our comments regarding warning labels on capacitors.

At the present time capacitors of the type represented by the Capacitor Section contain built-in discharge resistors. The NEMA standards require that the nameplate of the capacitor indicate whether or not resistor is installed. At the present time we do not include any other warning regarding short circuiting and grounding before handling on the nameplate. In stead our nameplate contains a statement cautioning the customer to read the instruction book before installing or operating. The instruction book does contain adequate warning concerning the hazards of handling a charged capacitor. We therefore do not intend at this time to add any additional warning to the nameplate.

With regard to polychlor diphenyls, we do not think that any of the NEMA committees should take action at this time regarding the addition of warning plates to capacitors. ANSI Committee C-107 on which NEMA is represented, is currently establishing guide lines for the handling and disposal of capacitors containing PCB's. We believe that a uniform warning label should be adopted by the industry and that this uniform warning label should be developed by ANSI C-107. We do agree that once agreement is reached on such a label that all capacitors within the scope of the section should bear this label.

Very truly yours,

R. J. Hopkins, Manager
Power Capacitor Product Engineering

-ep

cc: C. A. Parris
D. M. Sauter

Exhibit 4

NPC00007544

770183

Monsanto

MONSANTO INDUSTRIAL CHEMICALS CO.
260 Springside Drive
Akron, Ohio 44313
Phone: (216) 666-4111
July 28, 1975

Mr. Don Sauter
Plant Manager
WESTINGHOUSE ELECTRIC CORPORATION
Box 341
Bloomington, Indiana 47401

Dear Mr. Sauter:

We wish to bring to your attention problems associated with disposal of waste chlorinated biphenyl products in our incinerator at Sauget, Illinois:

1. Some recent returns have been in completely unsuitable drums which have been severely corroded and unsealed. Some drums have been overfilled so that expansion in transit has not been contained. Loose stowage in trucks has resulted in movement of the load in transit.

   The results have been spillage into the truck and in some cases, contamination of other goods in the truck which then had to be destroyed. We have had to hold trucks at our plant for cleaning, attracting demurrage charges and diverting plant personnel from productive tasks.

   The potential cost of cleanup, had such leaks in transit caused detectable environmental contamination, might have been significant.

   Truck cleaning at Sauget increases the risk of escape of PCB-containing effluent from our own plant which could jeopardize our ability to continue normal controlled production. It would indeed be distressing if[illegible]

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these incidents led to the inability of the industry to use chlorinated biphenyl in spite of industry efforts on ANSI C-107 and EIA ad-hoc committees.

We seek your assistance in ensuring that returns from your company are appropriately packed, sealed and stowed for return.

Costs incurred in handling inadequately packed returns will be billed to the company involved.

2. We have requested prior contact before EACH return so that we can send the required number of PCB Warning Labels. We are still receiving drums without warning labels. In the event of a spill in transit, the absence of warning labels could be a factor in assessing liability. We seek your help in ensuring that we send you enough suitable labels for each return.

3. We attach a copy of the form letter that we will be sending with labels to advise on correct return procedure.

You will note that this letter advises that our incinerator cannot handle solid waste. It is designed to handle liquid streams only. We still receive drums containing rags, sawdust, and metal and wooden components. In the past, our plant personnel have taken care to separate solid wastes and have arranged separate special disposal of the solid wastes. This will not continue. As from June 1, 1975, a charge of at least $100 will be made if labor is diverted to separating solid waste. Additionally, the solid waste will be suitably packaged and returned freight collect to the sender.

While we wish to continue to assist the electrical industry in disposal of liquid waste chlorinated biphenyl in our incinerator, we cannot and will not permit the service to become inoperable because of abuse by a small number of companies.

We thank you for your assistance in regulating returns from your company.

Sincerely,

David L. Mellon

D. L. Mellon
Regional Sales Manager
Specialty Products Group

DLM:js

CC: Keith Kelley
Larry Zimmerman

MEMORANDUM FOR FILE

Re: Testimony of Donald M. Saugster at Environmental Management Board Hearing September 30, 1976 and October 1, 1976

Following are my notes of what Mr. Saugster's testimony consisted of at the hearing. It is written in the first person, as if Saugster were speaking:

I've been the general manager at Westingouse for 8 years. The products of the Bloomington plant are cut out switches, reclosures and breakers, lightning arrestors, shunt capacitors, series capacitors and communication devices. The capacitors use a dielectric which is used to prevent electricity from shorting across poles. Our dielectric is called Inerteen. It's a PCB. A capacitor consists of dielectric material between aluminin plates. Part of the dielectric material is dielectric solids--paper and film. These dielectric solids withstand electric stress better if impregnanted with the dialectric fluid. The dialectric fluid is inserted in the capacitor can through a hole, which after testing for leaks, is placed in an impregnating oven for several days. The oven is filled with aroclor 1016. The the fluid is pumped out. When the oven is flooded, PCB gets on the exterior of the capacitor. Our first action is to wipe the capacitors with paper towels which are transported to scientific landfills. The capacitor is then washed. After washing the rinse water goes to the sewer after some recycling. The rinse water does not pass through a treatment facility.

We get our PCB's from Monsanto. We call them aroclor 1016. We have also purchased aroclor 1232 and 1221. Prior to 1971, aroclor 1016 was not available. In the last year at DAD we used one to two million pounds of PCBs. Sampling of our effluent has been done by us & the city.

We have data taken of our discharges, and documents relating the discharges at the plant. To my knowledge we have used the capacitor washer since 1958, and the wiping procedure began in 1976.

As to other disposal methods, ANSI C-107 addresses itself to the usage and disposal of PCBs. We have followed that standard. As to non-liquid wastes, we have placed our solids in sealed steel drums and sent them to a New York landfill since 1972. Before 1972 we used the Monroe County landfill for two months during the summer. Prior to that I don't recall the landfills that we used. I do recall that we fired one of our haulers, Neal, for not taking proper care of our trash.

My duties at DAD include environmental affairs. I've been aware that PCDs were a potential contaminant since about 1969. I learned this from the newspapers. One objective at our plant has been to minimize our discharge of PCBs into the environment. We did not consider PCBs a contaminant in 1968. In 1968 and 1969 we were not giving particular concern to the wash water. We began regular testing of our effluent waters in 1974 and 1975. We became aware of the availability of the solvent washer in 1972 and 1973. I do not know whether the Aqua Technics ~~egg~~ report included a recommendation of a solvent bath. I am aware of the ANSI C-107 standard, and to my knowledge DAD has met or exceeded this standard.

We first began using paper towels in 1976, and prior to 1976 did not use that step in our production process. Aroclor 1242 was used by us prior to 1971 and we also called it Interteen. As to whether Westinghouse took responsibility for materials at the dumps, I know that Westinghouse has had people visit the dumps.

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We used Aroclor 1242 before 1971, and aroclor 1016 after 1971. We called each Interteen. The ~~pacter~~ (Capacitor) cans are now made of stainless steel. We shifted over in the 1968 to 70 years. Only our power and series capacitors ~~and~~ communication equipment use Interteen.

I think of wastes (see ANSI-107 Section 3.36) as failed capacitors, sawdust, liquid aroclor, rags, floor dry, and other products with oil and liquid aroclor.

I was first aware that our wash water went to the STP in 1972 or 1973. I knew that because of a survey we did as to where PCBs might be escaping. At that time we made a list of priority items that deserved our attention in reducing our Interteen losses.

During the two months in 1972 that we used the Monroe County landfill, we sent (Some) solid wastes (Such) as failed capacitors, which included Interteen, and sawdust. We have used less and less sawdust since 1969 because our housekeeping has been better. I can't give the details of where we dumped locally prior to the summer of 1972, however, I believe that two other landfills were involved--Neal's Dump and Neal's Landfill. I believe that we have used three different trash haulers since 1968. All were located in-state. I don't remember the details of why we fired the trash hauler for doing an inadquate job. The people at Westinghouse who were responsible for such matters knew where the trash haulers were taking the trash, at least after 1969. Our reason for sending the trash to New York was that the landfill was EPA approved. We have sent no wastes contaminated with Interteen to local landfills since sometime in 1972. We made the switch because I was uncertain about the appropriateness of local landfills for such discharges. I don't know who hauls our wastes to New York.

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We began periodic monitoring of our sewer discharges in the early part of 1975. Our monitoring was done through a grab sample taken at an access hole five feet from our plant.. We have taken samples approximately once a month. We shifted over to the New York landfill as part of our policy of reducing PCB discharges and as we learned more about how to handle wastes.

In 1969 scientists were beginning to look at Interteen and trying to find out what PCBs were. At about the same time we began looking at ways to control Interteen wastes.

I do not know the specific locations of the landfills where we put wastes during the period 1968-72. I am not sure which landfill or when. I have never been to a landfill on Westinghouse's behalf. At times I have seen records as to landfills, and I have had reported to me that we used the Whitehall and Owen County dumps. I have been to the Dillman Road dump previously on my own behalf and not for Westinghouse.

I do not know the effects our in-plant corrective measures will have on our PCB discharges after December 1, 1976. Its effect on pipelining is unknown. This is a unique situation. We have made no investigation of residual hazards as to PCBs in the pipes. That is really our third priority, after abating PCBs going into the pipes and going to a new dialectric fluid. I have no opinion and no way to make a judgment as to whether work on the pipes would be necessary. We have made no effort to determine PCB contamination in our pipes.

I believe that Lew Schoaff has been employed as Materials Engineer at DAD since 1963. I do not know whether he has been a Process Engineer.

Westinghouse's opinion in 1972 was that Interteen was suspected of causing environmental problems. The indications were that we should reduce our PCB discharges.

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I have no opinion as to the potential hazards of PCBs in landfills versus the potential hazards from PCBs in our wash water. I do not know whether our 1972 procedures required capacitors to be sealed before depositing them in dumps. Beginning in about 1969, we drained off free liquid from capacitors before sending them to the landfill. Less than 50% of the Inerteen gets drained out by this procedure. The amount drained out is probably in the range of 10 to 50%.

I am familiar with ANSI C-107 (1974)--I believe it is currently in force. Section 3.3.6(2) deals with askarel wastes. Westinghouse has met its standards. It has also met the standards of Section 3.5.5(2), which refers to liquid askarel that settles out of the wash waterline settling tank. That askarel then goes to incinerators after being put in containers. Some of the PCBs, however, overflow and minute amounts go into the sewer. Mr. McClain participated in the ANSI C-107 development. Water with PCBs in it is not, in my view, askarel wastes.

ANSI C-107 was first initiated by Nema in 1970 or 1971. The industry then decided to get government and consumer input. ANSI published its first draft in about 1972. Our objective has been to meet the goals set forth by the standards. Our priorities as to clean up in 1971 were (1) liquid askarels (2) solid wastes (3) askarel reduced in each capacitor (4) plant housekeeping--drips, spills, etc. (5) alternate fluids and (6) secondary sources. The capacitor washer probably falls in number (4). We began working on (1) in 1968 or 1969, on (2) in 1970, on (3) in 1970, on (4) in 1970.

As to the capacitor washer itself we began working on a manifold fill system in 1971. The manifold fill did not make good capacitors.

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We began a research program on alternate fluids in 1971 at our Pittsburgh lab. We began the program because of possible environmental problems with PCBs. We wanted to be prepared with an alternate fluid. My policy as to priorities was probably never written.

We installed a pilot system for the manifold fill system and then, in 1973, ordered the equipment for a full system. By the end of 1974, 95% of our production was on the manifold fill. The capacitors were failing in the field by rupturing, and putting more PCBs in the environment than perhaps our washer was. In 1975 we stopped production and tried to make corrections in the manifold fill. We couldn't find the problem, and stopped manifold fill production in late 1975. Other than the manifold fill, we took no other short term measures to stop discharges into the sewer. The manifold fill was a major undertaking. In using the manifold fill, we noted that our discharge level decreased. In using it, there were no PCBs visible on the outside of the capacitor can.

We knew our effluent went to the utilities service sewers. We first tested the effluent in 1971. Our Sharon, Pennsylvania lab has testing facilities. Our data from Sharon is for 1974 to 1976. Our manifold fill data is for 1974.

I do not know of any hauling standards in ANSI C-107. McClain might know of them. The purchasing department makes contracts with our trash haulers.

Mr. Sawyer is in charge of permits. Mr. Sawyer or Mr. Schoaff would have knowledge of our answers to city questionnairres on sewer discharges. Dialectric oil could include mineral oil.

We brought in Aqua Technics because the city was talking of increasing sewer rates drastically. So we investigated, through Aqua Technics, our own treatment system.

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I don't recall whether Aqua Technics dealt with a solvent washer. Aqua Technics also did not deal with ~~acetylene~~ scrubbing tanks, or with scaling drains. I do not know whether we have used ~~acetelyn~~ scrubbing tanks since 1958. Sawyer would know this. I do not know whether Westinghouse made any response to the report. We have the report at the plant. Mr. Sawyer would know the test results of our water effluent into the sewer. We didn't consider other pretreatment of water because of the manifold fill system. However, ANSI C-107 was only one of many steps taken by us to comply with Section 3.3.5(2). I do not know of Monsanto's practices of informing us about the use and handling of PCBs--but I expect they do. I do not know whether they offer us indemnification for harm. I know Mr. Munson. I know he made tests of the landfill on Anderson Road. I do not know whether he surveyed landfill sites in Indiana.

DAD began placing notices on products that they contained PCBs in 1970 or 1971. This, again, was done because we felt PCBs were becoming suspect.

I know that after we stopped using the manifold fill system our discharges to the sewer went up.

It was 1969 before anybody could measure PCBs. The practice has become more widespread in the 1970s but DAD does not have the capability. In about 1970 Monsanto announced that they would make no sales of aroclor except in closed systems, i.e., transformers and capacitors. In 1971 Monsanto began offering 1016. It has 99% biodegradability in its homologs. In 1972 Monsanto began making sales only to an approved list of customers. In 1973 EPA announced proposed standards and withdrew them because of insufficient data in 1974. In 1974 Monsanto made available an alternate fluid. In 1975 EPA announced that it would use media publicity to rid PCB s from the environment. In November 1975 EPA held its national conference on PCBs. In January 1976

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the electrical industry announced that it would abandon PCBs by mid-1978.

As to alternate fluids, in 1971 DAD instituted its program. We examined several hundred candidate fluids, and during the period from 1971 to 1973 narrowed it to one fluid. We made some small capacitors from this fluid at first, and then some large capacitors at Bloomington in 1973. We began running our pilot facility on the new fluid. However, a review of safety procedures and methods of handling the new fluid disclosed possible hazards to our employees; consequently we abandoned the fluid in 1973, and began looking for a new fluid in the 1974 to 76 period. We have now found another fluid, and have put the fluid in 200 large capacitors distributed throughout the United States. We're getting the results on these capacitor's performance this year, and are making plant changes to accept the new fluid. The changeover to a new fluid requires a least a 30 month time period. Monsanto's 1974 fluid was never used for manufacturing at Bloomington but at R&D. (P) 983 is the WEstinghouse fluid that we came up with early in the 70's. The 30 month period to introduce a new fluid is solely a technical, and not an economic, limitation. Of that 30 months it would take six months to use up the stock of old capacitors made with the PCBs.

I do know that Munson tested Monroe County sites. PCBs have been used in much heat transfer equipment in the food industry and there is possible entry into the food chain there. There are many other uses such as food, dyes, printers ink, hydraulic brake fluids prior to 1971, oil on roads, carbonless paper, plasticizers, and as a carrier for pesticides. EPA has estimated that 1.4 billion pounds have been used--900 million in capacitors and transformers and 500 million in other products. Of the 900 million,

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750 million are still in use. Most of the other 500 million are not in use. We have never used Inerteen in any of the other uses.

Since 1971, DAD has purchased very small amounts--no more than a couple of drums--of 1221 and 1232. Before 1971, our purchases were of 1242 and 1232. At the time of our switch over to 1016, we had no stock pile of the older fluids.

The 1971 testing of our effluent showed traces of PCBs, ranging from the parts per billion range to the parts per million range. The Aqua Technics report was extremely low. There are probably 100 yards between our plant and the edge of our property. Munsen also tested streams in 1971. His testing was a one-shot effort. He also took fish samples. I do not recall the quantities of PCB in the fish. In 1972 and 1973 we did only sporadic testing. We never conveyed the results of our testing to the State or County. We did not convey the results of our testing of effluent to the City or Munsen tested streams and Monroe County and perhaps elsewhere. As I understand sampling today, no one can tell which aroclor is which after its release into the environment. It is impossible for me to estimate the number of failed capacitors in landfills. We have no log of capacitors going to particular landfills. I could estimate the number but not today.

We experienced approximately 100 ruptures of manifold fill capacitors over a two month period--or at least about 100 were called to my attention. I do not know how many PCBs were released to the environment upon rupture. The average capacitor has 25 pounds of PCBs in it.

There was no policy decision reflected in Munsen's discontinuation of testing. His test was a one-shot operation. The tests were requested by someone else and approved by me.

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Austin Fink is in charge of liability control and he might have the figures on the capacitor failures. We did not recall the manifold fill capacitors.

I do not recollect that we gave the solvent bath consideration at the time we abandoned the manifold fill. At the time of abandonment, our highest priority was an alternate fluid. We have never used aroclor 1254. The Munsen results are at the plant.

As to our indemnification agreement with Monsanto, I am aware of its contents generally but not of the agreement specifically. I understand that it changed our terms of sale to F.O.B. I have no recollection of whether the under the agreement Westinghouse recognized the hazards of PCBs. Our discussions of the contract, --and I participated in one discussion, did not go to food hazards. The discussions did go to holding Monsanto harmless. Mr. McDonough from Westinghouse was there. I can't recall whether liability after shipment was discussed.

Monsanto ships its aroclor from Saugat, Illinois. We have never bought imported PCB. We have also used PCBs in closed systems.

We began discussing our sampling with the City in the autumn of 1975. We receive oursampling results back from Sharon by letter. I do not know if Sharon retains the chromatographs. The Munsen data was ordered by J.W.Sterling, now deceased. I am not qualified to make a categorical statement that lower chlorinated homologs cannot be separated out after release into the environment. The records at our plant probably would contain the indemnification agreement with Monsanto. The 1971 testing was done at the time of our shift to 1016. I saw it in the 1971

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to 1972 time period, and I did not review it for the purposes of this hearing. It's true that we did not report any information to the city, county, state or EPA, but none of them asked for it in the 1971 to 1974 period. In late 1975 the city asked about it. The six month period I referred to earlier was to use up capacitors in warehouses.

LDB
10/2/76

National Electrical Manufacturers Association
155 East 44th Street • New York, N.Y. 10017 • 212-682-1500

July 3, 1974

TO ALL MEMBERS OF THE AD HOC COMMITTEE
ON POLYCHLORINATED BIPHENYLS (PCB'S) OF
THE CAPACITOR AND TRANSFORMER SECTIONS
AND THE ANSI C107 COMMITTEE ON GUIDE-
LINES FOR HANDLING AND DISPOSAL OF
ASKAREL AND ASKAREL-SOAKED MATERIALS

SUBJECT: BUREAU OF NATIONAL AFFAIRS (BNA) REPORT ON ENFORCEMENT OF WATER CONTROL ACT ON A CASE-BY-CASE BASIS

Gentlemen:

The attached is being sent to you, for your information.

Sincerely yours,

A. M. Salazar
Executive Secretary
Power Equipment Division

AMS:dk
ATT:
CC: James S. Nelson (GE)
P.S. Park (Monsanto)
Stuart Richel (GE)
E.L. Simons (GE)
N.H. Smith (Westinghouse)
James H. Wright (Westinghouse)
W. VanWart

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ENVIRONMENT: REP. WRIGHT SAYS WATER CONTROL ACT ENFORCEMENT SHOULD BE ON CASE-BY-CASE BASIS

Congress intended that the 1977 requirement for best practicable control technology under the 1972 Federal Water Pollution Control Act be determined on a case-by-case basis, Congressman James C. Wright, Jr. (D-Tex) said today.

Wright, chairman of the House Public Works Subcommittee on Investigations and Review, made his statement during an oversight hearing of the impact of the Water Act on industrial dischargers.

He said that what is practicable for one plant, for one body of water, or for one climate may not be practicable for another plant, water body, or climate. The conferees, in reaching an agreement on the 1972 Act, intentionally used the word "practicable" to encompass economics, local conditions, and capabilities of plants to meet effluent limitations requirements, Wright contended.

John R. Quarles, Deputy Administrator of the Environmental Protection Agency, said the agency has proceeded in developing effluent limitations on the basis of uniform national standards. EPA has, however, considered economics and varying climates in some of its effluent limitations, he added.

Another area which received some discussion was the effect of EPA's proposals to control thermal and other discharges by steam electric power generating plants.

Congressman Wright questioned the validity of requiring steam electric plants to spend $2.1 billion to comply with EPA's proposed effluent guidelines when the industry's daily raw waste loads of biological oxygen demand are negligible and when the effluent reductions to be achieved by the standards would only amount to 10 percent.

Quarles told the subcommittee that a tremendous amount of confusion has surrounded requirements for steam electric power generating plants. He said the $2.1 billion figure would be required to meet the effluent limitations guidelines established under section 304 of the Act. However, this industry receives special treatment under section 316(a) of the Act, because individual plants can demonstrate to EPA that the section 304 guidelines are not necessary. Therefore, Quarles stated, the cost to the industry of the requirements of the Act cannot be determined until section 316(a) exceptions are approved.

As a part of EPA's progress report on carrying out the Water Act, Quarles said total obligations for construction of municipal treatment works through fiscal 1974 are expected to reach $2.9 billion. As of June 22, present obligations totaled $2.4 billion.

Reporting on the national pollutant discharge elimination system created under section 402 of the Act, Quarles said 9,589 permits were issued as of May 31. A total of 6,429 permits were issued to industrial sources, 3,002 to municipal sources, and 168 to agricultural sources. Over 1,650 were issued by the states. Quarles said only 2 percent of issued permits have been challenged by industry or environmental groups.

Quarles said EPA's goal is to issue permits to all major dischargers and to a "substantial" number of minor dischargers by December 31. If the goal is met, he said, 80 to 90 percent of the pollution attributable to point sources will be under regulatory control.

EPA hopes to have approved 25 state permit programs by the end of this calendar year, Quarles said. Twelve programs already have been approved and Georgia, Kansas, and Minnesota are expected to receive approval this month.

EPA is having some difficulty in carrying out section 307 of the Act, which requires identification of toxic pollutants and establishment of standards for these pollutants, Quarles said. EPA issued an initial list of nine substances in September 1973 and currently is evaluating other substances for inclusion on the list. A decision on additions is expected by the end of 1974.

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Quarles said the most difficult problem connected with issuance of standards for the toxic pollutants is the one-year compliance time available to industry. Quarles said he anticipates seeking legislative revision of this deadline because it frequently will not provide enough time for compliance in cases where substantial modifications of a plant are required.

- 0 -

GOVT GRANTS: GSA, HEW, DOT PREFER TO AWAIT STUDY TO CLARIFY MEANING OF "CONTRACT", "GRANT", "COOPERATIVE AGREEMENT"

Three federal agencies today supported the aim of S 3514 to distinguish federal grant and cooperative agreements from federal contract relationships, but urged deferral pending completion of a current executive agency study aimed in the same direction.

Testifying before the Senate Government Operations Subcommittee on Federal Procurement on the bill introduced by the Subcommittee Chairman Lawton Chiles (D-Fla), Dwight A. Ink, General Services Administration Deputy Administrator, said that the executive agencies have begun preliminary work to get a study started in new areas consistent with the objectives of the bill, which he believes should provide in part for:

-- An analysis of congressional and executive branch requirements not covered by the Federal Assistance Review (FAR) effort which impede the development of federal-wide requirements for assistance programs.

-- More carefully developed definitions to make the distinctions contemplated by the proposed law, based upon the above recommended analysis.

Ink said that it is GSA's opinion that it would be desirable to build upon the work of the Commission on Government Procurement (COGP) by moving "forward with such a study before trying to establish either legislative or administrative definitions of contracts, grants, and cooperative agreements."

Although the Commission saw the need to establish a clear distinction between procurement and assistance relationships--with the primary distinction to be based on the principal purpose of the agreement between the Federal Government and the recipient--Ink opposed curtailing present flexibility.

He also spoke in opposition to the bill's proposal that a grant shall be used whenever there will be no substantial interaction between the Federal Government and the recipient, and that a cooperative agreement be used where there is a shared federal, non-federal responsibility for assuring performance. He questioned the desirability of trying to separate a cooperative agreement and a grant, "at least under the current wording of this bill," although he saw no objection to a study which would evaluate the pros and cons of using the cooperative agreement with respect to research, and a further effort to adequately define the term."

The definitions could have some adverse effect on agency programs, Ink said, noting that the Defense Department, the National Science Foundation, and the National Aeronautics and Space Administration felt that the bill could have a serious and adverse impact by impairing the use of grants to obtain basic scientific research.

He foresaw some potential confusion and redundant requirements in the bill's provisions for the transfer of surplus Government property to eligible recipients, maintaining that a grant agreement is not the appropriate legal instrument to effect a donation or transfer of surplus Government property.

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NEMA

OFFICIAL STANDARDS PROPOSAL

PROPOSED AMERICAN NATIONAL STANDARD GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR AND TRANSFORMER GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS, C107.1-( )

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION 155 EAST 44TH STREET, NEW YORK, N. Y. 10017

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GUIDELINES FOR HANDLING & DISPOSAL OF CAPACITOR & TRANSFORMER GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS

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SECTION 1

PREFACE

SECTION I

PREFACE

Askarels consisting of or containing polychlorinated biphenyls (PCB's) have been used in many applications for over forty years, but only recently was evidence discovered that PCB's are widely dispersed in the environment. Systematic investigations of the biological effects of PCB's have been undertaken within the past few years to establish the effects of specific formulations upon specific species. Some studies have shown that PCB's may be an environmental contaminant. Simultaneously, significant steps have been taken by U. S. industry to limit further PCB releases to the environment.

PCB's have been used in three broad types of applications for the past 40 years, as follows: (a) "open ended" applications....for example, in paints, specialty inks, paper coatings, plastics, etc., (b) "nominally closed" applications....for example, as the working fluid in hydraulic or heat transfer systems; and (c) "closed electrical system" applications....specifically, as the insulating fluid in certain types of transformers and capacitors. The Monsanto Company is the sole U. S. producer of PCB's. It has discontinued supplying the material for all applications of type (a) and (b).

Evaluations of the alternatives and risk/benefits involved in the continued use of PCB's in closed electrical systems are summarized in the following.

Benefits

1. Askarel-filled transformers do not burn or explode under conditions of electrical arcing that can cause fires or incendiary explosions as in mineral oil-filled transformers. Therefore, they are used in or near public, commercial or industrial buildings where oil-insulated transformers would present a potential danger to life and property.

2. Askarel-filled power and industrial capacitors are significantly smaller, more reliable, more durable, and safer than oil-filled capacitors. As a result, askarels have supplanted mineral oils in more than 90% of the power and industrial capacitors made today. Over the past few decades most of the equipment that incorporates such capacitors has been designed to take particular advantage of the size, safety and reliability benefits of askarel capacitors (e.g., many types are today less than 14% of the size of equivalent oil capacitors and have a life expectance of 10 to more than 20 years).

   The vital role that askarel-insulated transformers and capacitors has played in the safe, reliable, and efficient delivery of electric power is reflected in various standards, codes, and regulations that now effectively require or encourage continued use.

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Risks

In the United States, medical records show that over a nearly 40-year period the only adverse health effects experienced by U. S. workers exposed to askarels, either during the manufacture of these liquids or of electrical equipment containing these liquids, have been limited to occasional cases of non-chronic chloracne or other temporary skin lesions or irritations.

Askarel-filled transformers and capacitors are delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environment, transformer failures are limited to approximately 0.02% of the units in service per year. With respect to capacitors such losses are limited to approximately 0.02% of the askarel put into service per year. In addition, limited amounts of PCB's can get into the environment during the manufacture, delivery, improper use, maintenance, and repair and disposal of transformers and capacitors.

Specific control measures have been instituted by individual manufacturers and are supplemented and strengthened by national standards and procedures such as this America National Standard Institute Guide. This Guide provides information to prevent the inadvertent loss of PCB's to the environment at all stages from initial askarel manufacture through ultimate disposal.

Alternatives

1. For technical and code reasons it would be impossible to replace most askarel-filled transformers now in service with oil-filled units of equivalent ratings and reliability without major construction changes that would be required to compensate for the fire and explosion resistance of the askarel-filled units. For certain applications and locations, dry-type transformers may replace askarel-filled transformers.

   For new installations, while many of the limitations noted above would still apply, building and installation design provisions could be made to accommodate the use of oil-filled, open dry-type, or sealed dry-type transformers provided necessary technical, code, physical size, and cost considerations are properly evaluated.

2. The principal alternative to askarels for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1932 level and would necessitate redesign and replacement of such widely used equipment as fluorescent light fixtures and racks for power and induction heating capacitors, which could not now accommodate the increased size of oil capacitors while maintaining their present ratings.

3. The cost of askarel liquids is about five to ten times more than mineral oil. Thus, long before there were any environmental concerns about PCB's, there was a strong economic incentive to find other less expensive insulating liquids with the desirable characteristics of askarels. Since the 1930's at least 10 major chemical or electrical companies have invested large amounts of time and money in this search, all with no success. While potential substitutes that are more costly than askarels have also received some consideration (e.g., fluorinated liquids) little is known about either their electrical performance or possible ill effects upon the environment. There are today no fluids that can be used as a direct replacement for askarels.

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Interdepartmental Task Force on PCB's

An in-depth study of PCB's has recently been completed by five Executive Branch Departments of the federal government. This Interdepartmental Task Force on PCB's issued their report entitled, "Polychlorinated Biphenyls and the Environment", May, 1972.* The following conclusion is quoted from page 4 of this report:

> "The use of PCB's should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCB's in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCB's to all except manufacturers of electrical transformers and capacitors."

Reference should be made to the Interdepartmental Task Force Report for additional information and conclusions.

*Distributed by the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22151. Price - $6.00.

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SECTION 2

CAPACITOR GUIDELINES

GUIDELINES FOR HANDLING & DISPOSAL
OF CAPACITOR & TRANSFORMER GRADE ASKARELS
CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 2 - CAPACITOR GUIDELINES

I. INTRODUCTION

The environmental effects of askarels are under in-depth study by governmental and other agencies. Askarels have been considered as materials relatively harmless to humans based on about forty years of safe industrial usage. There has been no known instance of human injury when used under the normally accepted precautions and conditions of handling, in both manufacturing and user applications.

Traces of askarels are being found in the environment and in fish and birdlife. The long term genetic and ecological effects are not yet completely understood. For these reasons care should be taken to contain askarels and minimize their entry into the environment.

There are two general classes of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their high degree of non-flammability, they are used in transformers where personnel safety is of paramount importance.

Capacitor grade askarel has a lower degree of chlorination (composed primarily of the 3-chlorine isomers of biphenyl), a higher degree of biodegradability, and generally has not been found in animal life. It is used in capacitors where the extreme degree of non-flammability required in transformers is of less importance.

Although capacitor and transformer grade askarels both contain members of the PCB family, they do differ in composition, degree of biodegradability, persistence in nature, electrical stability, chemical stability, and degree of non-flammability (both are recognized as non-flammable). It is for these reasons that this portion of the Guideline is intended to apply to capacitor grade askarel.

II. CAPACITOR GRADE ASKAREL

In September of 1971, a new grade of capacitor impregnant, Aroclor 1016, was made available to the industry. This new grade contains a typical concentration of 0.4% by weight of the higher boiling homologs of the chlorinated biphenyls.* Aroclor 1016 replaces Aroclor 1242 which previously was the major capacitor impregnant and contained around 7% of the higher boiling homologs (the more persistent in nature). This 0.4% level of the higher boiling homologs should be the maximum concentration acceptable in any capacitor impregnant. Aroclor 1242 and 1254, previously used as impregnants, do not meet this requirement and should no longer be used in capacitors.

Aroclor 1016 has the same non-flammability rating by UL as Aroclor 1242. Its typical properties are given in Table I.

*Monsanto Method T-02302

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TABLE I - TYPICAL PROPERTIES OF AROCLOR 1016

PROPERTY & METHOD	TYPICAL VALUES
Color (APHA)	40, max.
Condition	Clear
Sp. Gravity @ 25/15.5°C (ASTM D1810)	1.362-1.372
Acidity (mg. KOH/g.) (ASTM D974,D664)	0.010 max.
Moisture	35 ppm, max.
Refractive Index @ 25°C (ASTM D1817)	1.6215-1.6235
Inorganic (Free) Chlorides (ASTM D1821)	0.05 ppm, max.
Pour Point (ASTM D97-57)	-14°C or lower
Dielectric Constant (ASTM D924-49) (1000 Hz @ 100°C)	4.70-4.90
Resistivity (ASTM D1169) (500 VDC @ 100°C. 0.1" Gap.)	500 x 10^9 ohm-cm. min.
Hydrolysis Stability Test (ASTM 1820-61) (As Chlorides)	0.5 ppm, max.
Thermal Stability Test (ASTM D1936) (As Chlorides)	0.4 ppm, max.
Distillation Range (ASTM D20-56 Corrected)	
10% Distilled by Wt.	323°C, min.
90% Distilled by Wt.	356°C, max.
Higher Boiling Homologs (Monsanto Method T-02302)	0.4% max.
Sulfates (ASTM D117-31)	None
Dielectric Strength @ 25°C (ASTM D877-49)	35 KV min.
Flash Point, Cleve. Open Cup (ASTM D92-57)	338°F min.
Fire Point	None to Boiling Point
Corrosion Test (6 hrs. @ 210°C with bright Al foil)	
Change in wt. of Al %	0.0
Viscosity @ 100°F (SUS) (ASTM D88-56)	71-81
Specific Heat @ 25°C	0.30
Coefficient of Expansion (ASTM D1903)	0.00068 cc/cc/°C
Fixed Chlorine (Carius)	41.3 $\pm$ .5%
Power Factor @ 100°C 60 Hz (Monsanto Method T-2273)	
Bulk	1 % max.
Drums	4% max.

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III. PLANT HOUSEKEEPING AND EMPLOYER SAFETY

The following procedures and limits are intended to be minimum requirements to be met by manufacturers and users of capacitors containing askarel. Handling, control and disposal procedures are given, together with exposure limits and indicated antidotes and cleanup procedures.

A. Material. Askarel for use in capacitors should consist of homologs and isomers of chlorinated biphenyl with the concentration of the higher boiling homologs at about 0.4%. Aroclor 1016 is considered the standard impregnant meeting these requirements.

Commonly used solvents include benzene, kerosene, acetone, trichloroethane, trichloroethylene, and perchloroethylene. Typical vapor pressure data for Aroclor 1016 are:

0°C =	0.001 mm
25°C =	0.006 mm
150°C =	4.3 mm
200°C =	29.0 mm

At 25°C and 760 mm Hg pressure, saturated air contains approximately 0.09 mg/liter.

(1 mg/liter = 90.0 ppm (v/v))
(1 ppm (v/v)= 0.011 mg/liter)

B. Bulk Fluid Shipment, Receiving, and Transfer. Shipment of askarel from point of manufacture to point of receiving should be done in closed containers: rail tank cars; truck tanks; marine or barge tanks; or sealed drums. Containers should be labeled as to contents, and carry a label cautioning against loss of fluid to the open environment. Containers used for transport of askarel should not be used for storage or transport of other material without being completely cleaned of all traces of askarel. (Cleaning procedures must take cognizance of precautions against excessive exposure and of the need for proper disposal of contaminated cleansing solvents and materials as set forth in Part V of this Section.) Transfer from shipping containers to processing systems should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluid lost by leakage or spills from the transfer system and from the storage containers. Not done

Drums to be retired from use should be cleaned before crushing, delivery to scrap dealers , or other disposal. Contaminated cleaning fluids and materials should be disposed of as indicated in Part V.

C. General Safety Precautions. Although it is generally accepted that exposure to capacitor grade askarel is not hazardous provided simple precautions are taken, exposure should still be avoided.

(1) Vapors. The odor of askarel is noticeable well below the maximum air concentrations considered safe. Up to 1.0 milligram per cubic meter of air has been determined to be the maximum safe level of exposure during an 8-hour work day (Reference 8 - Part G below). The procedures for performing the necessary analyses are contained in SECTION 5, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls."

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(1) Vapors (continued)
Breathing vapor or fumes from heated askarel should be avoided. Provisions should be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure to askarel (especially at 55°C or higher). The gases produced, when a [illegible] is decomposed by very high temperatures (such as that of a [illegible] ric arc) in the presence of air or organic insulating materials [illegible] a high percentage of hydrogen chloride, and small percentages of carbon dioxide, carbon monoxide, and oxygen. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarel is necessary under emergency conditions, an approved gas mask or self-contained breathing apparatus should be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of an accident. If the odor of askarel is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval, and be maintained on a regular schedule in accordance with the manufacturers' recommendation.

(2) Liquid. Unlike insulating oil, there is virtually no fire hazard in handling askarel. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to the eye tissue.

Operating procedures should be such as to minimize or eliminate contact with askarels. Use of eye protection is recommended. The use of porous gloves which can absorb and retain askarels is to be avoided. Barrier creams* or resistant gloves** should be used if contact is unavoidable. Use of enclosed transfer and handling equipment, processing equipment, and mechanical washers reduces direct contact.

Medicinal washes or mild detergents followed by application of cold cream will reduce irritation resulting from askarel contact with an open cut or abrasion.

Safety glasses with side shields or a face shield should be worn when handling askarels. If eye contact to liquid askarel occurs, the eyes should be irrigated immediately with large quantities of running water for fifteen minutes and then examined by a physician. (A drop of castor oil has been found to reduce irritation caused by eye contact).

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under the supervision of a physician.

* e.g. PLY No. 9 Gel by Milburn Co., Detroit, Michigan, or Kerodex #71 distributed by Ayers Laboratories, P.O. Box 8236, Church Street Station, New York, N. Y. 10049

** Edmont, Solvit 5-352, sold by Mersick of Bridgeport, 22 Cross St.,Bridgeport, Conn.06601

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(2) Liquid (continued)
Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or use of toilet facilities.

D. Manufacturing Housekeeping. Manufacturing equipment and operating procedures should safeguard against loss of askarels to the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 55°C. Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all askarel processing areas to ensure against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

Spills of askarel should be removed promptly by use of absorptive material such as sawdust, or trapped and removed by pumping or other suitable means.

Waste fluids containing askarel not suitable for reconditioning or reuse should be collected (by means of traps, drip pans, trays, etc.) from the various parts of the manufacturing and processing area (including washers or other cleaning devices). Disposal should be in accordance with Section V.

Wiper rags, clothing and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled laundering or disposal (see V. Scrap Disposal Procedures).

E. Disposal of Askarel Wastes. Methods for disposal of liquids and saturated solids generated by the manufacturing operation should be in accordance with those outlined in Part V of this Guide, and should include (but not be limited to) the following:

1. Liquid askarel contaminated by aliphatic materials and other substances such as to make it unsuitable for reclaiming as a dielectric fluid.

2. Liquid askarel from solvent operations or water/detergent type washers.

3. Saturated earth or other absorbent media from filtering operations.

4. Saturated sawdust or other absorptive materials from spills.

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E. Disposal of Askarel Wastes (continued)

5. Saturated filters from vapor control devices and other filters.

6. Saturated wastes (paper, rags, etc.).

7. Saturated, spent gasket materials.

8. Askarel contaminated vacuum pump oils.

9. Askarel contaminated stream jet vacuum system condensates.

F. Miscellaneous Procedures

1. Spills by leakage from finished capacitors should be cleaned up promptly by use of absorbent media which should then be moved to containers for that purpose within the containment area, and later disposed of properly.

2. Askarel wastes should never be disposed of down effluent drains or sewers. The utmost care must be exercised to prevent accidental loss by these avenues to the environment.

3. Capacitors failing test or otherwise designated for disposal must be controlled and handled in accordance with the intent of the procedures above, finally being disposed of by one of the means outlined in Part V of this Section.

G. References

1. Monsanto Industrial Chemicals Company: Technical Bulletin O-FF/1R, Aroclor® Polychlorinated Polyphenyls (Biphenyls) (November 1971)

2. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. AMA Arch. Environ. Health 9:545 (1964).

3. Treon, J.F., F.P. Cleveland, J. Cappel, and R.W. Atchley: The Toxicity of the Vapors of Aroclor 1242 and Aroclor 1254. Amer. Ind. Hyg. Assoc. Quart. 17:204 (1956).

4. Elkins, H.B.: The Chemistry of Industrial Toxicology. John Wiley and Sons, Inc., New York (1959).

5. Drinker, C.K., M.F. Warren, and G.A. Bennet: The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 19:283 (1937).

6. Drinker, C.K.: Further Observations on the Possible Systemic Toxicity of Certain of the Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 21:155 (1939).

7. Greenburg, L., M.R. Mayers, and A.R. Smith: The Systemic Effects Resulting from Exposure to Certain Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 21:29 (1939).

8. Hygienic Guide Series "Chlorodiphenyls" (January-February 1965) by the American Industrial Hygiene Assoc., 210 Haddon Avenue, Westmont, N. J. 08108.

IV. CONTROL OF WATER EFFLUENTS

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems in capacitor manufacturing plants are probably contaminated as a result of past practices, and askarel traces may continue to show up in effluent streams for some time. However, the level should continue to decrease with the proper containment of askarel wastes and no further discharges into drain systems. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams, and that accidental spills be prevented from getting into such streams.

A. Concentration Limits. The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.

B. Monitoring Streams. On a regular basis consistent with plant situations, all effluent streams should be analyzed. The procedures for performing the necessary analyses are contained in SECTION 5, ANALYSIS OF WATER AND SEDIMENT FOR POLYCHLORINATED BIPHENYLS. This procedure or its equivalent should be used.

C. Methods for Minimizing Effluent Stream Contamination. The ideal approach is to totally isolate all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant. Carbon adsorption, limestone beds, and solvent extraction are techniques which can be applied to reduce the askarel content of effluent streams. These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

V. SCRAP DISPOSAL PROCEDURES

The manufacture and use of capacitors involve processes producing askarel saturated solids, and liquids containing or composed entirely of askarel, which should be disposed of as wastes. Disposal should be done in a manner consistent with proper concern for the environment, and which minimizes any release of askarels to the environment. Specific sources of these materials appear throughout this document but may be placed into three categories:

1. Capacitor units impregnated with askarel; Production and Field Rejects.
2. Manufacturing process liquid wastes containing askarel.
3. Solid waste purposely or accidentally saturated with askarel.

A. Disposal of Capacitor Units

Scrap capacitor units can be generated during manufacturing processes, or during field service.

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A. Disposal of Capacitor Units (continued)

Production rejects are those capacitors which are rejected after the impregnation process, in the course of production by the capacitor manufacturer. They may be rejected for mechanical or electrical reasons, or because of obsolescence.

Field rejects are those which are rejected, or which for other reasons are to be scrapped, after shipment from the plant where they were manufactured.

Disposal Procedures

1. Production Rejects

Rejected capacitors in capacitor manufacturing plants represent a concentration of askarel. It is important that their disposition be made in a manner consistent with proper concern for the environment. Therefore, capacitors should be disposed of only in supervised dry landfill sites which meet all applicable State & local requirements.

Care should be exercised to insure that no loss of liquid will occur during transportation to the disposal site.

Incineration of scrap capacitors in facilities designed to accept such solids is a disposal alternative as such services become available in the future.

2. Field Rejects

Small capacitors (defined as containing less than 2 pounds of askarel) are practically always used as components in other electrical or electromechanical equipment. Typical examples of large quantity usage of such capacitors are in fluorescent lamp ballasts and residential air conditioning equipment. Failure of such capacitors may result in scrapping of the device of which it is a part (as in a fluorescent ballast), or replacement and scrapping of the individual capacitor (as in a room air conditioner). However, the majority of such capacitors do not fail in service, but are scrapped as a result of wearout or obsolescence of the devices in which the capacitors are used as components. Thus, the matter of disposal is characterized by low concentration of small quantities of askarel throughout the country and indeed throughout the world. Fortunately, the nature of the devices and equipment in which such capacitors are used is such that they are normally disposed of in dry landfills as a matter of convenience. Since it is impractical at present to exercise any meaningful control over disposition of the bulk of such devices and equipment, it is imperative that askarel used for impregnating small capacitors be limited to the recently introduced type which contains a typical concentration of 0.4% of the higher boiling homologs.

Large capacitors (those incorporating more than 2 pounds of askarel) should be disposed of according to the procedure for Production Rejects (see paragraph 1 of this Section).

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B. Disposal of Liquid Wastes

All waste askarel or liquid wastes containing askarel should be disposed of according to one of the following procedures:

1. Incineration

Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability and finally suitable scrubbers to remove HCl formed; e.g., (1) two-second dwell time at 2000°F and 3% excess oxygen in stack gas; (2) 1-1/2 second dwell time at 2700°F and 2% excess oxygen in stack gas.

These facilities should meet applicable requirements of the State in which located, and should control effluents within the limits set forth in this document.

2. Toxic and Hazardous Waste Disposal Sites

Certain landfill sites have been classified by State and Federal Governments as suitable for the disposal of toxic and hazardous liquids. Where such approved sites exist they may be used for the disposal of liquid wastes described in this document. (See Section 4).

The following guidelines should be observed in the packaging and shipment of liquid wastes for disposal.

1. Transportation to the disposal facility should be in containers which will prevent leakage and accidental loss of askarel to the environment.

2. Containers should be labeled as to contents and precautions relative to loss to the environment.

3. Containers used for this purpose should not be used for any other materials or retired from service until they are completely cleaned. Any solvents used in cleaning these containers will be contaminated with askarel and should be disposed of according to the same procedures herein described.

C. Disposal of Solid Wastes (see "A" for Scrap Capacitors)

All solid wastes which have been saturated with askarel should be disposed of by the following procedure:

The saturated wastes should be placed into leak-proof containers and transported to a supervised dry landfill site meeting State requirements. Alternatively, they can be disposed of by incineration in State approved facilities.

Solid absorbents used for spills can be disposed of uncontained in the supervised dry landfill site — transport to the site should be in closed containers. Alternatively, solid incineration can be used in accordance with Part B (see Section 4 for facilities).

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VI. LABELING

Capacitor units vary greatly in size and in end use or application. Small capacitor units are frequently applied as a component of another piece of equipment such as a fluorescent lighting ballast, a roadway or area lighting luminaire, a motor, etc. In such applications a label on the capacitor unit referencing approved disposal procedure would not normally be visible when the piece of equipment is disposed of.

For the above reasons the method of relating disposal instructions for small capacitors and large capacitors shall be treated separately and in the following manner.

Small Units (Incorporating less than 2 pounds of askarel)

Small capacitors are defined as those which contain askarel in quantities up to about two (2) pounds each and in which the free liquid does not exceed 0.4 pound. They are hermetically sealed in metallic cases. Such capacitors are applied as a component of a larger piece of equipment. Attaching a label to such equipment referencing this Guideline or describing disposal procedures would be of limited practical value.

Large Capacitor Units (Incorporating more than 2 pounds of askarel)

The capacitor manufacturer should affix a label in a conspicuous place, referencing this document or describing disposal procedures consistent with it. This label should contain as a minimum the following information:

CAUTION

This capacitor contains a Polychlorinated Biphenyl (PCB). To avoid possible environmental contamination, it should be disposed of only in supervised dry landfill areas meeting State requirements or in incineration facilities designed for disposal of PCB's.

See AMERICAN NATIONAL STANDARDS INSTITUTE GUILDELINE for further information (available form manufacturer or ANSI, 1450 Broadway, New York, N. Y. 10017).

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SECTION 3

TRANSFORMER GUIDELINES

GUIDELINES FOR HANDLING AND DISPOSAL OF CAPACITOR AND TRANSFORMER-GRADE ASKARELS CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 3 - TRANSFORMER GUIDELINES

I. General Guidelines

A. Definitions - Types of Transformer Askarels

The term askarel generally describes a broad class of nonflammable synthetic halogenated hydrocarbon insulating liquids widely used in transformers, reactors, and accessory equipment operated at power frequencies. Askarels of various compositional types are in use (for the general properties and types see ASTM D-2283). Under arcing conditions the gases produced, while consisting of predominantly noncombustible hydrogen chloride, can contain varying amounts of combustible gases depending upon the askarel type.

The following trademarks are used by electrical manufacturers to designate the askarels used in their products:

Asbestol
Chlorextol
Elemex
Inerteen
No-Flamol
Pyranol
Saf-T-Kuhl

B. Safety Precautions

Based on about 40 years of safe industrial usage, askarels have been considered as relatively harmless materials to humans. There has been no known instance of human injury when askarels are used under the normally prescribed conditions of precaution and handling.

Although it has been generally thought that exposure to transformer askarels is not hazardous, provided simple precautions are taken, exposure should still be avoided and minimized.

1) Vapors

The odor of askarel is noticeable -- well below the maximum safe air concentrations. Depending upon the composition of askarel used, from 0.5 to 1.0 mg per cubic meter of air has been determined to be the upper safe level of exposure during an eight-hour work day. (See American Industrial Hygiene Association Hygienic Guide Series - January/February, 1965.) The procedures for performing the necessary analyses are contained in Section 5, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls." This procedure or its equivalent shall be used.

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SECTION 3 - (Cont'd)

B. Safety Precautions

1) Vapors - (Cont'd)

Breathing vapor or fumes from heated askarels should be avoided. High concentration of vapors can cause irritation of the eyes, nose, throat and upper respiratory tract. Provisions shall be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure of hot askarels (55C or higher). The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials, contain a high percentage of hydrogen chloride, and small percentages of other gases. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarels or its arced products is necessary under emergency conditions, an acceptable gas mask of the organic canister-type or self-contained breathing apparatus must be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of accident. If the odor of askarel or its arced products is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval, and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

2) Liquid

Unlike mineral insulating oil, there is no fire hazard in handling askarels. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should avoid contact with any askarels. The use of porous gloves which can absorb and retain askarels is to be avoided. Resistant gloves and aprons of the Neoprene, polyethylene, Viton type should be used if contact is unavoidable. In case of spillage on the clothing, the clothing should be removed as soon as practical, the skin washed and clothing laundered.

Medicinal washes or mild detergents followed by application of cold cream will reduce irritation resulting from askarel contact with an open cut or abrasion.

Safety glasses with side shields or a face shield should be worn when handling askarels. Eyes exposed to liquid askarel should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician if the irritation persists. (A drop of castor oil has been found to reduce irritation caused by eye contact.)

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SECTION 3 - (Cont'd)

B. Safety Precautions

2) Liquid - (Cont'd)

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or use of toilet facilities.

C. Transport Container Marking

Any transformer askarels, new or used, as shipped in tank cars, tank trucks, drums, cans, etc., should be labeled with the following:-

C A U T I O N

THIS PRODUCT CONTAINS POLYCHLORINATED BIPHENYLS (PCB'S). CARE SHOULD BE TAKEN TO PREVENT ENTRY INTO THE ENVIRONMENT THROUGH SPILLS, LEAKAGE, USE, VAPORIZATION, OR DISPOSAL OF LIQUID OR CONTAINERS. AVOID PROLONGED BREATHING OF VAPORS OR MISTS. AVOID CONTACT WITH EYES OR PROLONGED CONTACT WITH SKIN. IF SKIN CONTACT OCCURS, REMOVE BY WASHING WITH SOAP AND WATER. FOLLOWING EYE CONTACT, FLUSH WITH WATER. IN CASE OF SPILLAGE ONTO CLOTHING, THE CLOTHING SHOULD BE REMOVED AS SOON AS PRACTICAL, SKIN WASHED, AND CLOTHING LAUNDERED.

D. Receiving, Handling and Storage of Askarels

Askarels are shipped in tank cars, tank trucks, steel drums, metal cans and test sample containers. When received all containers should be inspected for leaks.

1) Storage Tanks

Storage tanks should be erected so that inspection can be made for leaks or spills. Construction should be such that inadvertent leakage or spills are prevented from reaching streams and sanitary or storm sewers.

2) Tank Car and Tank Trucks

All bulk shipment equipment should be inspected for leaks immediately upon receipt. Drain pans must be provided to prevent spillage from unloading hoses and connections. Askarel liquid collected in drain pans should be placed in "Scrap Askarel" drums for disposition.

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SECTION 3 - (Cont'd)

D. Receiving, Handling and Storage of Askarels

3) Steel Drums, Cans, and Test Sample Containers

On delivery all such shipments will be carefully inspected for leaks. The containers should be stored indoors in an area especially selected for this purpose. A curb should enclose the area to provide a basin for containing the askarel from one or more containers, should the containers be damaged. The area must not have a drain which is connected to a sanitary or storm sewer.

If an indoor storage area is not possible, the containers should be stored under a lean-to.

E. Water Effluents - Sampling, Concentration Limits, Analytical Procedures

1) Control of Water Effluents

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems from manufacturing plants, repair shops and installation sites may be contaminated as a result of past practices. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams, and that accidental spills be prevented from getting into such streams.

a. Concentration Limits

The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.

b. Monitoring Streams

All plant effluent streams should be monitored on a regular basis, consistent with plant situations. The procedures for performing the necessary analyses are contained in Section 5, "Analysis of Water and Sediment for Polychlorinated Biphenyls." This procedure or its equivalent shall be used.

c. Methods for Minimizing Effluent Stream Contamination

The ideal approach is to totally isolate all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant.

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SECTION 3 - (Cont'd)

F. Disposal Procedures and Services

1) Sources of Materials Requiring Special Handling and Disposal Procedures

Liquids containing PCB's and solids containing or contaminated with PCB's may be obtained from any of the following sources:- transport containers, transformer manufacturing processes, in-test failures, liquids contaminated beyond reclamation, in-service transformer leaks and failures, askarel-filled transformers scrapped for any reason, etc.

2) Classification for Disposal of Materials Containing PCB's

In general, there are three types of materials for disposal; liquids, burnable solid materials containing PCB's and non-burnable solid materials contaminated with PCB's.

a. Liquids

Liquids containing PCB's requiring disposal by high-temperature incineration may consist of the following:

1. PCB's contaminated with mineral oil.

2. Mineral oil contaminated with PCB's.

3. Non-reclaimable contaminated transformer askarels, arced askarels, askarels from manufacturing spills, and sump accumulation, etc., rich in PCB's, and askarels from holding basins, drip and drain pans, washings, sample jars and containers, etc.

b. Burnable Solid Waste Material Containing PCB's

These materials can be disposed of by high temperature incineration and consist of cellulosic materials, rags, pressboard, wood, sawdust, fuller's earth in bulk or in cloth bags, blotter papers, nitrile or cork gaskets, etc.

c. Non-burnable Solid Waste Materials Containing or Contaminated with PCB's

These materials may consist of coil structures, steel, copper, aluminum filter units of the steel mesh construction type, askarel drums, cans, etc.

Materials of this nature should be allowed to drain with the liquid collected in drip pans, etc. Further removal of adhering PCB's can be accomplished by washing or solvent extraction with kerosene or other approved washing liquids such as perchloroethylene or trichloroethylene. Accumulated liquids can be disposed of as indicated in "a" above. Solid materials may be handled as normal scrap.

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SECTION 3 - (Cont'd)

F. Disposal Procedures and Services

3) Shipment of Scrap Liquids for Disposal

All liquid scrap material should be placed in appropriate metal transport drums, properly labeled, for shipment to a company offering an acceptable disposal service.

4) Shipment of Burnable Solid Waste Material Containing PCB's for Disposal

Material of this type should be placed in open head drums with suitable closures and with the drum properly labeled for shipment to a company offering an acceptable disposal service.

5) Liquid and Solid Waste Disposal Service Organizations

a. General

Disposal of askarels and askarel-soaked materials should be accomplished by means in which there is no significant release of askarel to the environment. At present, disposal is accomplished by carefully-controlled incineration of liquids and soaked software, and by controlled land-fill burial of apparatus and other hardware from which askarel has been previously drained and washed.

Present knowledge indicates that proper incineration must involve a suitable balance between dwell time and temperature in the incinerator plus oxygen availability and finally suitable scrubbers to remove HCl formed; e.g., (1) two-second dwell time at 2000°F and 3% excess oxygen in stack gas; (2) 1-1/2 second dwell time at 2700°F and 2% excess oxygen in stack gas.

These facilities should meet applicable requirements of the state in which located, and should control affluents within the limits set forth in this document.

Controlled land-fill or deep-well disposal can be used where permitted by Federal, State and local regulations.

b. Costs

In addition to the normal costs of collecting scrap liquids and solids for disposal, additional costs borne by the owner of such scrap include shipping container, cost of transport to the disposal service organization and a disposal fee usually based upon a per gallon or per pound charge.

c. Disposal Services

Organizations offering disposal services are listed in Section 4, including location, facilities available, types of material handled, and disposal procedures used. Specific shipping directions, disposal procedures and costs should be obtained from the company.

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II. Specific Guidelines

A. Transformer Manufacturers, Service Shops, etc. - Housekeeping

1) It is necessary to assume that in filling equipment with askarel and further handling of this equipment that an askarel spill may occur. Therefore, it is necessary to provide facilities and a procedure for clean-up to prevent contamination.

a. Askarel Filling Area

1. The location of the askarel filling area should be adjacent to the test area and final shipping area to minimize the danger of damage of units during handling.

2. The main manufacturing area for filling of equipment with askarel should be provided with impervious surface floors or suitable basins so constructed that any inadvertent leakage or spills are prevented from reaching streams, sanitary, or storm sewers. All askarel-handling equipment such as pumps, hoses, etc., shall be of the askarel-resistant type.

3. Drip pans shall be provided for hose connections and filling valves.

b. Special Containers for Scrap Materials

1. Drums labeled "Scrap Askarel" should be available for handling all spilled and waste askarel from sumps, failed units, drip pans, sample jars, etc.

2. Open-head drums with suitable closures and labeled "Scrap Burnable Askarel Waste" should be available for handling contaminated cellulose insulation, rags, paper pressboard, wood, gaskets, sawdust, etc.

3. Separate containers for handling steel, copper, and aluminum, each adequately marked, shall be provided for the components of contaminated core and coil assemblies. These containers are required for the various materials when repairing or scrapping assemblies.

4. Containers for supplies of material for absorbing small askarel spills or clean-up of larger spills should be provided.

c. Conditioning of Askarels

1. Askarel Conditioning Equipment

a. The conditioning unit should be located either in the storage tank area or the main transformer manufacturing area for filling with askarel.

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II. Specific Guidelines - (Cont'd)

A. Transformer Manufacturers, Service Shops, etc. - Housekeeping

c. (Continued)

2. Fuller's Earth

a. Conditioning of new askarel or recycled askarel requires fuller's earth treatment. The spent fuller's earth in cartridges or bags when replaced should be allowed to thoroughly drain over drip pans to remove as much liquid askarel as possible. The cartridge units of steel mesh construction should be placed in the "Steel Contaminated with Askarel" container for disposition. Cloth bags filled with fuller's earth shall be placed in the "Scrap Burnable Askarel Waste" container for disposition.

d. Teardown of Units for Repair or Scrap

1. Teardown Procedure

a. Drain all askarel from the unit either into a holding tank for reuse or into the drum labeled "Scrap Askarel" for disposition, then allow sufficient time for all the askarel to drain from the core and coils.

b. Remove the core and coil assembly from the transformer. Sufficient absorbent material should be placed on the floor to absorb any askarel fluid that still drips from the transformer.

c. Place all materials in the appropriate salvage containers during the dismantling for later disposition.

d. All used materials, including rags, sawdust, tape, etc., regardless of quantity, shall be put into the appropriate containers for disposition.

B. Transformer Labeling

1) New Transformers

All new transformers that contain PCB's shall have a label of adequate durability permanently and prominently attached to the tank by the manufacturer, giving adequate warning and instructions. A suggested label would include the following:-

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II. Specific Guidelines - (Cont'd)

B. Transformer Labeling

1) New Transformers - (Cont'd)

C A U T I O N

THE INSULATING LIQUID IN THIS TRANSFORMER CONTAINS POLYCHLORINATED BIPHENYLS (PCB's). CARE SHOULD BE TAKEN TO PREVENT ENTRY INTO THE ENVIRONMENT. IN CASE OF MALFUNCTION OR LEAKS, CONSULT THE INSTRUCTION MANUAL OR THE MANUFACTURER.

2) In-Service Transformers

The transformer manufacturer should make suitable labels available with a similar warning as in B-1 above for use on existing transformers.

C. Transformer Users - Shipping, Installation, Maintenance, Sampling, Apparatus Disposal

1) General

Askarel-filled transformers are delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environment, such cases are extremely rare.

2) Transportation and Receiving

Immediately upon receipt of the equipment and following any transportation or handling accident which could affect the integrity of the tank, bushings or radiators, examine the transportation vehicle, tank and fittings for any leakage or spillage that may have occurred in shipping. If leakage is evident, correct the cause and soak up spillage with absorbent materials such as sawdust, following with clean-up of the affected area with rags soaked with kerosene or other approved solvent such as perchloroethylene or trichloroethylene. Collect all materials used for proper disposition as described in Section 3 1 F, "Disposal Procedures and Services."

3) Installation and Periodic Inspection

Following installation, the unit should again be inspected for any damage or leakage. It is recommended that periodic in-service inspections be made for any leaks.

4) Filling, Filtering, or Drying Askarel

Most askarel units are shipped with the proper amount of askarel but if it becomes necessary to top off a unit, follow the manufacturer's instructions.

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II. Specific Guidelines - (Cont'd)

C. (Cont'd)

4) Filling, Filtering, or Drying Askarel - (Cont'd)

If necessary to dry or fuller's earth treat an askarel unit, follow the manufacturer's instructions. When filtering or conditioning askarel, all of the same precautions previously described apply as to drip pans, proper disposal of filter media, etc.

5) Sampling

It is common practice to sample askarel from a transformer for periodic maintenance testing. As previously described, such samples should be taken in a manner to avoid any contamination of the environment. Washings should be collected for proper disposal. Field and laboratory test samples, washings, etc., should also be collected for proper disposal.

6) Transformer Disposal

The ultimate disposal of an askarel-filled transformer may be accomplished in either of two ways.

a. Complete drainage and dismantling with the proper disposal of the askarel and askarel-soaked components as described earlier in the section "Disposal Procedures and Services."

b. Disposition of askarel transformers by means of junk or scrap dealers should be avoided unless a transformer is first drained, followed by soaking of the interior with a suitable solvent. Accumulated liquids and washings are to be disposed of as described earlier.

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SECTION 4

DISPOSAL SERVICES

SECTION 4

DISPOSAL SERVICES

In addition to the managed, supervised dry land-fill sites which may be used for disposal of askarel-containing scrap, the following additional known facilities and services have been established, and others may be available.

A. CHEM-TROL POLLUTION SERVICES, INC. - 4818 Lake Avenue
Blasdell, New York 14219
Phone 716-826-5850

Facilities and Services Capable of Handling

Liquids - Askarels alone or mixed with solvents or oils. Disposal by high temperature incineration.

Solids (Software) - Askarel soaked compounds, rags, cartons, absorbing earths, etc. Disposal by incineration or scientific land-fill.

Solids (Hardware) - Capacitors, transformer tanks, cores, askarel soaked metals. Disposal by scientific land-fill. Has solvent extraction capability.

B. MONSANTO COMPANY - 800 N. Lindbergh Blvd.
St. Louis, Missouri 63166
Phone 314-694-3352

Facilities and Services Capable of Handling

Liquids - Askarels alone or mixed with other oils or solvents by high temperature incineration. Liquid is pumped through gun with atomizing steam into incinerator. Temperatures maintained at 2000-2500°F with auxiliary natural gas. Exit gases are quenched to 180°F by contacting with water. Gas is then passed through a high-energy venturi scrubber for removal of particulates. Before exhausting to air (110°F), gases are passed through a packed column scrubber to remove HCl.

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C. NUCLEAR ENGINEERING COMPANY - Eastern Division
P. O. Box 146
Morehead, Kentucky 40351
Phone 606-784-6611

Disposal Division
Sheffield, Illinois
Phone 815-454-2624

Facilities and Services Capable of Handling

Provides containerization, transportation and disposal services of all liquids and solids (including hardware). Disposal is in controlled chemical and scientific landfill area. AEC licensed for radioactive waste disposal. Has two West Coast locations in states of Washington and California in addition to above.

D. ROLLINS-PURLE, INC. - Box 3349
Wilmington, Delaware 19899
Phone 302-478-5150

Facilities and Services Capable of Handling

Liquids - Askarel alone or mixed with solvents or oils. Disposal by high temperature incineration.

Solids (Software) - Askarel soaked compounds, rags, cartons, absorbing earths, etc. Disposal by incineration at combustion temperatures up to 2500°F. Incineration gases are scrubbed, and entrained solids removed before exhausting to air.

Disposal facilities are available at the following locations.

Logan: Rollins-Purle, Inc.
Route 322
Logan Township
Bridgeport, New Jersey 08014

Baton Rouge: Rollins-Purle, Inc.
Scenic Hwy. & W. Cheatham Lane
Scotlandville
East Baton Rouge Parish
Louisiana 70807

Houston: Rollins-Purle, Inc.
Tidal Road & Hwy. 134
Deer Park, Texas 77536

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SECTION 5

APPENDIX

ANALYTICAL PROCEDURES AND LABORATORY SERVICE ORGANIZATIONS

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SECTION 5

APPENDIX

ANALYTICAL PROCEDURES AND LABORATORY SERVICE ORGANIZATIONS

Analytical procedures for determining PCB's in air, water, and sediments are attached as Part I and Part II.

The following laboratories are representative of those offering services for PCB analyses:

Carus Chemical Corp.
1375 Eighth Street
LaSalle, Illinois 61301
Phone 815-223-1500

Limnetics, Inc. (Subsidiary of Carus Corp.)
6132 West Fond du Lac Avenue
Milwaukee, Wisconsin 53218
Phone 414-461-9500

Gollob Analytical Service Corp.
47 Industrial Road
Berkeley Heights, New Jersey 07922
Phone 201-464-3331

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PART
I

A TENTATIVE PROCEDURE FOR THE DETERMINATION OF AIRBORNE-POLYCHLORINATED BIPHENYLS.

SCOPE

This procedure is based on techniques originally developed for the isolation and determination of polychlorinated biphenyls (PCBs) in water, soil/sediment, and biological materials.

Absolute confirmation of PCB structure is not obtained with this method. Where needed, additional structure proof should be obtained using techniques such as mass spectrometry to further identify GC fractions.

PRINCIPLE

Airborne PCBs are absorbed in toluene by drawing the air through one or more fritted bubblers or impingers in cylinders filled with toluene. After sampling a suitable amount of air the scrubbing solvent is diluted or concentrated and interfering components if present, are removed by chemical treatment and column absorption chromatography. The amount and type of PCB present is determined by electron capture chromatography (EC/GC).

REAGENTS

Hexane	Nanograde, Mallinckrodt Chemical Works Works, Catalog No. 4159.
Toluene	Nanograde, Mallinckrodt Chemical Works, Catalog No. 8092.
Sodium Sulfate	Anhydrous, granular: AR grade, Mallinckrodt Chemical Works, Catalog No. 8042. Heat at 400° C for one hour prior to use.
Alumina Adsorption	(for chromatographic analysis) 80/200 mesh, Fisher Scientific Co., Catalog No. A540. Heat at 400°C for a minimum period of 4 hrs. and deactivate with 5% (w/w) distilled water.
	Alumina column preparation: Fill a chromatographic column with hexane up to the point where the reservoir joins the column and push a glass wool plug to the bottom with a glass rod. In a 50 ml beaker measure 35 ml of deactivated alumina (~30g), and pour this slowly into

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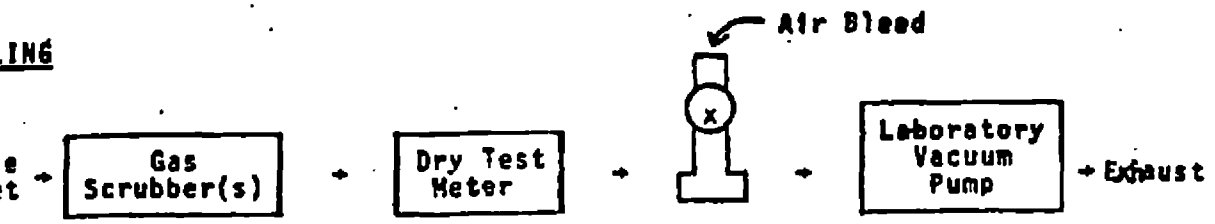
	the column. Tap or vibrate the column to settle the alumina and top the alumina with 2-3 cm of anhydrous sodium sulfate. Wash the column with 50-100 ml of hexane prior to the addition of the sample.
Distilled Water	Extracted with hexane to remove hexane soluble electron capturing impurities.
Sulfuric Acid	Analytical Reagent Grade, SG = 1.84
Potassium Hydroxide	Analytical Reagent Grade
Ethanol	Formula 2B
2.5% (w/v) Alcoholic Potassium Hydroxide	Dissolve ~12.5 grams of AR grade KOH in 500 ml of ethanol.
9/1 (v/v) Sulfuric Acid - Water	Carefully add 270 ml of AR grade sulfuric acid to 30 ml of distilled water in a 500 ml iced beaker
PCB Standards	Aroclor 1016, 1221, 1242, 1248, 1254 and 1260

APPARATUS

1. Gas Scrubbing Bottles, High form, ground glass joint, Fritted Coarse Discs.
2. Separatory funnels equipped with ground glass stoppers and Teflon stopcocks: 125, 250, 500, 1000 and 2000 ml capacities.
3. Kunderna-Danish Evaporative Concentrators, 500 ml capacity equipped with 3-ball Snyder columns and graduated 5 ml capacity vials: Ace Glassware Company, Catalog No. 6707.
4. Chromatographic columns, glass, 10" x 20 mm (OD) with a 5" x 50 mm (OD) reservoir at the top, equipped with Teflon stopcocks.
5. Flat bottomed boiling flasks, 125 ml capacity: Ace Glassware Company, Catalog No. 6896, Code - 04.
6. Liebig Condenser, 200 mm in length: Ace Glassware Company, Catalog No. 5915, Code - 12.
7. Hot plates, Corning PC-100: Fisher Scientific Company.
8. Water bath, Thelco, Precision Scientific, Model No. 84, Fisher Scientific Company.
9. 10 µl Hamilton Syringes, Catalog No. 701N.
10. Dry Test Meter or Wet Test Gas Meter.
11. Laboratory Vacuum Pump.
12. Rotating vacuum evaporator.
13. Usual laboratory glassware.

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SAMPLING



SAMPLING TRAIN

The air to be sampled for airborne PCBs is drawn through a gas scrubber(s) and a dry test meter using a laboratory vacuum pump. The sampling flow rate is controlled by bleeding in air via a needle valve located between the pump and the meter. At the end of the sampling period the metered gas volumes are corrected for temperature and pressure to cubic meters at 25° C. and 760 mm. Hg.

It is important to note that neither the capacity nor the efficiency of the gas scrubber(s) for removal of airborne PCBs have been experimentally evaluated. For this reason it is best to minimize the sampling flow rate and maximize the sampling time period to obtain measurable amounts of PCBs. When high flow rates must be employed or a larger capacity may be needed it is recommended that several gas scrubbers be used in tandem.

It is cautioned, that until the efficiency and capacity of the toluene gas scrubber has been experimentally established, this procedure should be only used to measure relative PCB levels sampled under equivalent conditions.

PROCEDURE

1. After scrubbing the desired amount of air, record the metered volume, pressure, and temperature.
2. Quantitatively transfer the scrubbing solvent to a round bottom flask and reduce the volume to approximately 2 ml by rotary vacuum evaporation.
3. Quantitatively transfer the concentrate to 30 ml beaker with the aid of several small portions of toluene.
4. Inject a fraction of a µl of the concentrate into the gas chromatograph to check for interferences and determine the approximate level of PCBs present. If no interferences are present dilute or concentrate the sample to a known volume, as determined by the electron capture chromatogram, and proceed with the gas chromatographic analysis.

5. If interferences are present proceed with the chemical treatment and column chromatographic clean up procedures.

6. Transfer the concentrate to a 125 ml extraction flask with the aid of several small portions of solvent.

7. Evaporate the concentrate just to dryness with a gentle stream of dry filtered air and add 25 ml of 2.5% alcoholic potassium hydroxide.

8. Add a boiling chip, put a water condenser in place, and allow the solution to reflux for 45 minutes.

9. After cooling, transfer the solution to a 250 ml separatory funnel with the aid of 25 ml of distilled water.

10. Rinse the extraction flask with 25 ml of hexane and add it to the separatory funnel.

11. Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate and transfer the lower aqueous phase to a second separatory funnel.

12. Extract the saponification solution with a second 25 ml portion of hexane. After the layers have separated, add the first hexane extract to the second separatory funnel and transfer the aqueous alcohol layer to the original separatory funnel.

13. Repeat the extraction with a third 25 ml portion of hexane. Discard the saponification solution and combine the hexane extracts.

14. Carefully add 25 ml of the sulfuric acid solution (9:1 concentrated sulfuric acid/water) to the hexane extracts.

15. Stopper the separatory funnel and shake vigorously for at least one minute. Allow the layers to separate and discard the lower aqueous acid layer. Repeat this step until the acid layer is colorless.

16. Wash the hexane with 25 ml portion of water. Discard the water wash.

17. Filter the hexane extract through a 4" funnel plugged with glass wool which is covered with a layer of sodium sulfate into a Kunderna-Danish evaporative concentrator.

18. Add a small boiling chip, put the Snyder column in place and reduce the hexane volume to less than 5 ml by heating the apparatus in a 80-90° C. water bath.

19. After cooling, remove the 5 ml graduated tube and transfer the hexane extract to an alumina adsorption column washing it in with several 5 ml portions of hexane.

20. Carefully add 100 ml of hexane to the column reservoir and collect the total eluent in either a 250 ml volumetric flask or a Kunderna-Danish evaporative concentrator.

21. If the column eluent is collected in a volumetric flask, dilute to volume with hexane and proceed with the gas chromatographic analysis.

22. If the column eluent is collected in a Kunderna-Danish evaporative concentrator, reduce solvent volume, cool, dilute to volume and proceed with gas chromatographic analysis.

Electron Capture Gas Chromatographic Procedure:

Instrument: F&M 402 Biomedial Gas Chromatograph

Detector: High Temperature Ni^{63} Electron Capture Cell
6 mm x 6' Glass Column, 4% XE-60 on 80/100 mesh
Chromosorb W, HP, AW-DMCS

Column Temperature: 160-190° C.

Detector Temperature: 300° C.

Injection Port Temperature: 195-215° C.

Pulse: 150

Flow Rates: Helium Carrier ~60 ml/min
Argon-Methane Purge ~120 ml/min

Using EC/GC as the determinative step, inject in duplicate 1-10 µl of each solution into the chromatograph. By comparison with standard solutions injected, in duplicate, under the same operating conditions, determine the amount and type of Aroclor using the individual or total peak height and area methods.

DISCUSSION

Sample Concentration

Concentration of sample extracts is necessary, prior to clean up by chromatographic or chemical means, to reduce sample size and increase sensitivity. The preferred method of concentrating allows minimum loss through volatilization or chemical decomposition and requires a minimum time. The three methods of solvent volume reduction most commonly used are evaporation by exposure to a stream of air, evaporation employing a Kunderna-Danish evaporative concentrator equipped with a Snyder column, and evaporation under reduced pressure. All three techniques have been used without encountering any significant losses from volatilization or chemical alternation.

Column Adsorption Chromatography and Chemical Clean Up

Silica gel, Florisil and Alumina deactivated with 0, 1.0, 1.5, 2.0 and

5% water were investigated as adsorbants for the elimination of interferences. Alumina (5% water) was found to be more effective and reproducible than either silica gel or Florisil. The activity of alumina varies with age and lot, therefore, 5% water was added to the alumina, after heating for a minimum of 4 hours at 400°C, to insure a reproducible activity.

Saponification and subsequent extraction of the sample with sulfuric acid is an effective way to remove a number of chlorinated hydrocarbon interferences as well as other matrix interferences. PCBs are not affected.

Electron Capture Gas Chromatography

Columns

Column performance is the key to effective gas chromatographic analysis and as such the choice of column materials is particularly important. Ideally, the support employed should be inert, mechanically strong, and of high surface area. Chromosorb W, HP, AW-DMCS fulfills these requirements and is recommended for this work.

A variety of polar and non-polar liquid phases have been investigated. The following columns have been found to provide adequate separation, etc., for use in PCB analysis by electron capture: 4% (w/w) DC-200, SF-96, OV-17, SE-30, SE-54, XE-60, Apiezon L, and 6% QF-1. DC-200 and XE-60 or QF-1 have been found to be the most suitable of these liquid phases.

Another important consideration when working with an extremely sensitive detector and consequently low levels of materials is column conditioning. With polar phases such as XE-60 and QF-1, operating a new column overnight at a temperature 25-50°C higher than to be used during analysis results in a more stable column. A no-flow conditioning technique is employed to condition non-polar columns. The column is purged with carrier gas, heated for 30 minutes at an elevated temperature without carrier flow and then cooled to room temperature. At the end of this cycle, the carrier flow is resumed and the conditioning is completed as in the case of the polar liquid phase. Two precautions: during conditioning, the column should not be connected to the detector and one should not exceed the maximum safe temperature of the liquid phase.

Since all liquid substrates bleed to one degree or another and columns eventually degrade, all new columns should be characterized with two column performance indicators - the number of theoretical plates (N) and a tailing factor (T). p,p'-DDT is employed to check these parameters because it is known to degrade on "poor" columns. In this manner, one can determine if the performance of a new column is satisfactory and when the column performance begins to fall off. A column is considered good if the number of theoretical plates per foot is on the order of 400-500 with tailing factors of 1.0-1.5. Calculation of these parameters is shown in the Appendix. Additionally, there should be no significant

extraneous peaks upon injection of a pure p,p-DDT standard.

Other chromatographic conditions that can be adjusted are column temperature and flow rates. Although resolution of a mixture increases with decreasing temperature, a temperature should be chosen that allows the elution of all components within a convenient time period. The flow rates shown are optimum for a given instrument, column and detector system. These should be adjusted if better results can be achieved.

Two gas chromatographic systems have been used for PCB analysis - F & M Model 402 and 5750. Any system of instrument and column suitable for chlorinated pesticides is satisfactory for PCB analysis. The use of the high temperature Ni^{63} electron capture cell is highly recommended. The ability to operate at higher temperatures prevents maintenance problems due to contamination from high boiling components. Glass columns should also be employed.

Detection and Measurement

Quantitative determinations employing the electron capture detector are non-stoichiometric measurements made by comparing peak heights or areas for known concentrations with those for unknown compositions. Three variations of the peak height or area quantification procedures have been employed.

Case I	EC gas chromatogram of PCB unknown unchanged with respect to standard PCB with no evidence of interferences.
Case II	EC gas chromatogram of PCB unknown altered with respect to standard PCB with no evidence of interferences.
Case III	EC gas chromatogram of PCB unknown unchanged with respect to standard PCB with evidence of interference.

The amount of PCBs in Case I samples is determined by preparing a plot of the major peak height or area vs. concentration. With Case III samples, a peak free from interference is used. When dominant interferences are present, one or more of the chemical clean up procedures is employed.

In all cases, the response of the electron capture detector must be linear for quantitative analysis.

Contamination

In determining PCB's in biological materials by electron capture gas chromatography, laboratory sources of contamination can be a major

problem. The samples and extracts should never be allowed to come in contact with materials other than glass, Teflon or metal. Laboratory glassware should be thoroughly washed with hot, soapy water, rinsed with distilled water, acetone, and then hexane. All equipment should also be rinsed again with hexane just prior to use and blanks should be frequently carried through all steps of the procedures to insure against the possibility of contamination.

SENSITIVITY

Two parts per billion
Absolute sensitivity - 0.5×10^{-9} grams
Volume injected - 5 µl.
Final volume of extract - 5 ml.
Sample size - 250 ml.

ANALYSIS OF WATER AND SEDIMENT FOR POLYCHLORINATED BIPHENYLS

SCOPE

This methodology was developed for the determination of the amount and type of polychlorinated biphenyls (PCB) in water and sediment samples. Absolute confirmation of PCB structures is not obtained with this method. Structure proof can be obtained using additional techniques such as mass spectrometry to further identify the GC fractions.

PRINCIPLE

The PCB(s) in water and sediment samples are extracted into an organic solvent. Interfering components are then removed from the extracts by chemical treatment and column adsorption chromatography. The amount and type of PCB present is determined by electron capture gas chromatography (EC/GC).

REAGENTS

Hexane	Nanograde, Mallinckrodt Chemical Works, Catalog No. 4159.
Acetonitrile	Nanograde, Mallinckrodt Chemical Works, Catalog No. 2442.
Sodium Sulfate	Anhydrous, granular: AR grade, Mallinckrodt Chemical Works, Catalog No. 8042. Heat at 400°C for one hour prior to use.
Alumina Adsorption	(for chromatographic analysis) 80/200 mesh, Fisher Scientific Co., Catalog No. A540. Heat at 400°C for a minimum period of 4 hrs. and deactivate with 5% (w/w) distilled water. Alumina column preparation: Fill a chromatographic column with hexane up to the point where the reservoir joins the column and push a glass wool plug to the bottom with a glass rod. In a 50 ml beaker measure 35 ml of deactivated alumina (~30g), and pour this slowly into the column. Tap or vibrate the column to settle the alumina and top the alumina with 2-3 cm of anhydrous sodium sulfate. Wash the column with 50-100 ml of hexane prior to the addition of the sample.
Distilled Water	Extracted with hexane to remove hexane soluble electron capturing impurities.

Sulfuric Acid	Analytical Reagent Grade, SG = 1.84
Potassium Hydroxide	Analytical Reagent Grade
Ethanol	Formula 2B
2.5% (w/v) Alcoholic Potassium Hydroxide	Dissolve ~12.5 grams of AR grade KOH in 500 ml of ethanol
9/1 (v/v) Sulfuric Acid - Water	Carefully add 270 ml of AR grade sulfuric acid to 30 ml of distilled water in a 500 ml iced beaker
PCB Standards	Aroclor 1242, 1248, 1254 and 1260

APPARATUS

1. Separatory funnels equipped with ground glass stoppers and Teflon stopcocks: 125, 250, 500, 1000 and 2000 ml capacities.
2. Kunderna-Danish Evaporative Concentrators, 500 ml capacity equipped with 3-ball Snyder columns and graduated 5 ml capacity vials: Ace Glassware Company, Catalog No. 6707.
3. Chromatographic columns, glass, 10" x 20 mm (OD) with a 5" x 50 mm (OD) reservoir at the top, equipped with Teflon stopcocks.
4. Sintered glass filter funnels, 600 ml capacity, 90M.
5. Flat bottomed boiling flasks, 125 ml capacity: Ace Glassware Company, Catalog No. 6896, Code - 04.
6. Liebig Condenser, 200 mm in length: Ace Glassware Company, Catalog No. 5915, Code - 12.
7. Hot plates, Corning PC-100: Fisher Scientific Company.
8. Water bath, Thelco, Precision Scientific, Model No. 84, Fisher Scientific Company.
9. Reciprocating variable speed shaker, Eberbach Corporation, Fisher Scientific Company.
10. 10 µl Hamilton Syringes, Catalog No. 701N.
11. 32 oz. all glass morters and pestles.
12. 8 x 12 x 2" (2-1/2 qt.) Pyrex baking dishes.
13. U.S. Standard Sieve, No. 30, Fisher Scientific Company.
14. Usual laboratory glassware.

SAMPLING

It is to be assumed that a rather wide variety of sampling techniques may be employed in collecting samples submitted for analysis. For this reason water and sediment samples should be treated as follows:

Water

Where possible the entire water sample, including the container in which it was collected, is extracted with hexane. With larger samples, where this is not physically possible, the containers are simply agitated and a 250 ml portion used for analysis.

Sediment

Any excess water is decanted and the entire sediment transferred to a glass baking dish to air dry at room temperature. The dried material is transferred from the dish into a mortar and ground. The ground sediment is sieved, remixed, and a 250g portion taken for analysis.

PROCEDURES

Extraction of Water Samples

1. Extraction of water samples - after agitating, transfer the entire aqueous sample or a 250 ml aliquot into a graduated glass cylinder. Record the volume of the sample and quantitatively transfer it to a separatory funnel with distilled water.

2. Rinse the graduated cylinder with two 50 ml portions of hexane and add each to the separatory funnel.

3. Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate and transfer the lower aqueous phase to a second separatory funnel.

4. Extract the water sample a second time with a 50 ml portion of hexane. After the layers have separated, add the first hexane extract to the second separatory funnel and transfer the aqueous layer to the original separatory funnel.

5. Repeat the extraction with a third 50 ml portion of hexane. Discard the aqueous layer and combine the hexane extracts.

6. Filter the combined extracts through a 4" funnel plugged with glass wool which is covered with sodium sulfate. Collect the filtrate in a Kunderna-Danish evaporative concentrator, add a small boiling chip, put the Snyder column in place, and reduce the hexane volume to less than 5 ml by heating the apparatus in a 80-90°C water bath. (CAUTION: SOLVENT VAPORS MUST BE VENTED TO A HOOD.)

7. After cooling, remove the 5 ml graduated tube and transfer hexane extract to an alumina adsorption column washing it in with several 5 ml portions of hexane.

8. Carefully add 100 ml of hexane to the column reservoir and collect the total eluent in either a 250 ml volumetric flask or a Kunderna-Danish evaporative concentrator.

9. If the column eluent is collected in a volumetric flask, dilute to volume with hexane and proceed with the gas chromatographic analysis.

10. If the column eluent is collected in a Kunderna-Danish evaporative concentrator, reduce solvent volume, cool, dilute to volume and proceed with the gas chromatographic analysis.

Extraction of Sediment and Soil Samples

1. Decant off any excess water and transfer the entire sediment sample to a glass baking dish. Air dry at ambient temperature (heat should not be applied).

2. When dry, transfer the soil/sediment to a mortar and grind. Sieve the ground material through a No. 30 mesh sieve and weigh 250g (to the nearest 0.01g) into a 16 oz. narrow neck screw cap (aluminum foil liner) glass bottle.

3. Moisten the soil with water (~10 ml) and add 150 ml of acetonitrile. Cap the bottle tightly, and mechanically shake for a minimum period of 1 hour.

4. Quantitatively transfer the acetonitrile extract into a 600 ml sintered glass filter funnel containing a 1/4" layer of anhydrous sodium sulfate. Collect the filtrate in a 600 ml beaker (vacuum filtration may be necessary).

5. After the acetonitrile has completely drained into the beaker, wash the bottle twice with 50 ml portions of acetonitrile, adding each wash to the funnel after the previous has completely percolated through the sediment.

6. Quantitatively transfer the extract to a Kunderna-Danish evaporative concentrator, add a small boiling chip, put the Snyder column in place, and reduce the solvent volume to less than 5 ml by heating the apparatus in a 80-90°C water bath. (CAUTION: SOLVENT VAPORS MUST BE VENTED INTO A HOOD.)

7. After cooling remove the 5 ml graduated tube and transfer the concentrate of extracts to a 125 ml extraction flask with the aid of several small portions of solvent.

8. Evaporate the extract just to dryness with a gentle stream of dry filtered nitrogen and add 25 ml of 2.5% alcoholic potassium hydroxide.

9. Add a boiling chip, put a water condenser in place, and allow the solution to reflux for 45 minutes.

10. After cooling, transfer the solution to a 250 ml separatory funnel with the aid of 25 ml of distilled water.

11. Rinse the extraction flask with 25 ml of hexane and add it to the separatory funnel.

12. Stopper the separatory funnel and shake vigorously for at least 1 minute. Allow the layers to separate and transfer the lower aqueous phase to a second separatory funnel.

13. Extract the saponification solution with a second 25 ml portion of hexane. After the layers have separated add the first hexane extract to the second separatory funnel and transfer the aqueous alcohol layer to the original separatory funnel.

14. Repeat the extraction with a third 25 ml portion of hexane. Discard the saponification solution and combine the hexane extracts.

15. Carefully add 25 ml of the sulfuric acid solution (9:1 concentrated sulfuric acid/water) to the hexane extracts.

16. Stopper the separatory funnel and shake vigorously for at least one minute. Allow the layers to separate and discard the lower aqueous - acid layer. Repeat this step until the acid layer is colorless.

17. Wash the hexane with 25 ml portion of water. Discard the water wash.

18. Filter the hexane extract through a 4" funnel plugged with glass wool which is covered with a laye· of sodium sulfate into a Kunderna-Danish evaporative conce·trator.

19. Add a small boiling chip, put the Snyder column in place and reduce the hexane volume to less ·han 5 ml by heating the apparatus in a 80-90°C water bath

20. After cooling, remove the 5 ml graduated tube and transfer the hexane extract to an alumina adsorption column washing it in with several 5 ml portions of hexane.

21. Carefully add 100 ml of hexane to the column reservoir and collect the total eluent in either a 250 ml volumetric flask or a Kunderna-Danish evaporative concentrator.

22. If the column eluent is collected in a volumetric flask, dilute to volume with hexane and proceed with the gas chromatographic analysis.

23. If the column eluent is collected in a Kunderna-Danish evaporative concentrator, reduce solvent volume, cool, dilute to volume and proceed with gas chromatographic analysis.

Electron Capture Gas Chromatographic Procedure

Instrument: F&M 402 Biomedical Gas Chromatograph
Detector: High Temperature Ni^{63} Electron Capture Cell
6mm X 6' Glass Column, 4% XE-60 on 80/100 mesh
Chromosorb W, HP, AW-DMCS

Column Temperature: 160°C
Detector Temperature: 300°C
Injection Port Temperature: 195°C
Pulse: 150

Flow Rates

Helium Carrier—60 ml/min
Argon-Methane Purge
—120 ml/min

Using EC/GC as the determinative step, inject in duplicate 1-10 µl of each solution into the chromatograph. By comparison with standard solutions injected, in duplicate, under the same operating conditions, determine the amount and type of Aroclor using the individual or total peak height method.

The electron capture detector should also be used to guide the isolation procedures. Water and sediment extracts can be checked for the presence of PCBs and/or interferences by injecting µl portions of the extracts at various points in the extraction and concentration schemes. In this manner, it can be determined if the sample needs to be concentrated or diluted and if the clean up procedures should be employed.

DISCUSSION

Extraction

The extraction of PCB's from water employing hexane as the extractant is found to be quantitative and to be sufficiently simple and rapid for use as a routine procedure.

The evaluation of this method was based on spiking water samples with standard acetone solutions of PCB's. The spiking method consisted of adding the PCB's in acetone (25-50 µl) to 500 ml of tap water in a 32 oz. narrow neck screw cap jar. After thoroughly mixing, duplicate 225-250 ml aliquots were taken and subjected to the proposed sample preparation and work up as outlined. The results were quantified by preparing a calibration curve using standard hexane solutions of the PCB's used to spike the water samples. The major isomer peak height was used to construct the calibration plot.

The average recovery and deviation achieved substantiated the applicability of the method for the quantitative recovery and analysis of PCB's from water at the ppb-ppm level.

No PCB recovery experiments from spiked sediment and soil samples have been performed. Instead, several of the residual solids representative of some of the types of sediment or soil analyzed were re-extracted with hexane/acetone (40/60) in a soxhlet extractor to test for the efficiency of the acetonitrile extraction step. The hexane, after isolation by dilution with distilled water was then carried through the purification steps. Recoveries by soxhlet extraction have indicated that the acetonitrile extraction of PCB's was essentially quantitative in the cases checked.

Sample Concentration

Concentration of sample extracts is necessary, prior to clean up by chromatographic or chemical means, to reduce sample size and increase sensitivity. The preferred method of concentrating allows minimum loss through volatilization or chemical decomposition and requires a minimum time. The three methods of solvent volume reduction most commonly used are evaporation by exposure to a stream of air, evaporation employing a Kunderna-Danish evaporative concentrator equipped with a Snyder column, and evaporation under reduced pressure. All three techniques have been used and no significant losses from volatilization or chemical alternation have been encountered. However, the Kunderna-Danish evaporative concentrator and the stream of air methods are easier to use.

Column Adsorption Chromatography and Chemical Clean Up

Silica gel, Florisil and Alumina deactivated with 0, 1.0, 1.5, 2.0 and 5% water have been investigated as adsorbants for the elimination of interferences. Alumina (5% water) is found to be more effective and reproducible than either silica gel or Florisil. The activity of alumina varies with age and lot, therefore, 5% water is added to the alumina, after heating for a minimum of 4 hours at 400°C, to insure a reproducible activity.

Saponification and subsequent extraction of the sample with sulfuric acid is an effective way to remove a number of chlorinated hydrocarbon interferences as well as other matrix interferences. PCB's are not affected.

Electron Capture Gas Chromatography

Columns:

Column performance is the key to effective gas chromatographic analysis and as such the choice of column materials is particularly important. Ideally, the support employed should be inert, mechanically strong, and of high surface area. For these reasons, Chromosorb W, HP, AW-DMCS is recommended for this work.

A variety of polar and non-polar liquid phases have been investigated. The following colums are found to provide adequate separation, etc. for use in PCB analysis by electron capature: 4% (W/W) DC-200, SF-96, OV-17, SE-30, SE-54, XE-60, Apiezon L, and 6% QF-1. DC-200 and XE-60 or QF-1 are the most suitable of these liquid phases.

Another important consideration when working with an extremely sensitive detector and consequently low levels of materials is column conditioning. With polar phases such as XE-60 and QF-1, operating a new column overnight at a temperature 25-50°C higher than is to be used during analysis results in a more stable column. A no-flow conditioning technique is employed to condition non-polar columns. The column is purged with carrier gas, heated for 30 minutes at an elevated temperature without carrier flow and then cooled to room temperature. At the end of this cycle the carrier flow is resumed and the conditioning is completed as in the case of the polar liquid phase. Two precautions: during conditioning, the column should not be connected to the detector and one should not exceed the maximum safe temperature of the liquid phase.

Since all liquid substrates bleed to one degree or another and columns eventually degrade, all new columns are characterized with two column performance indicators - the number of theoretical plates (N) and a tailing factor (T). p,p' -DDT is employed to check these parameters because it is known to degrade on "poor" columns. In this manner, one can determine if the performance of a new column is satisfactory and when the column performance begins to fall off. A column is considered good if the number of theoretical plates per foot is of the order of 400-500 with tailing factors of 1.0-1.3. Calculation of these parameters is shown in the Appendix. Additionally, there should be no significant extraneous peaks upon injection of a pure p,p' -DDT standard.

Other chromatographic conditions that can be adjusted are column temperature and flow rates. Although resolution of a mixture increases with decreasing temperature, a temperature should be chosen that allows the elution of all components within a convenient time period. The temperatures given are optinum for 42% chlorinated biphenyl, temperatures are increased when specifically analyzing for the higher chlorinated biphenyls, i.e., 54%, 60%, etc. The flow rates shown are optimum for a given instrument column and detector system. These should be adjusted if better results can be achieved.

Two gas chromatographic systems have been used for PCB analysis - F & M Model 402 and 5750. Any system of instrument and column suitable for chlorinated pesticides is satisfactory for PCB analysis. The use of the high temperature Ni^{63} electron capture cell is highly recommended. The ability to operate

at higher temperatures prevents maintenance problems due to contamination from high boiling components. Glass columns should also be employed.

Detection and Measurement:

Quantitative determinations employing the electron capture detector are non-stoichiometric measurements made by comparing peak heights or areas for known concentrations with those for unknown compositions. Except for sharp peaks, peak area measurements are usually more reproducible than peak height measurements but are extremely time consuming unless a recording integrator is employed. However, peak height measurements are as accurate as disc integration of triangulation and if the peak shape represents a gaussian curve, the height may be considered independent of the base. Consequently, peak height measurements were generally used. Three variations of the peak height quantification procedure were employed.

Case I — EC gas chromatogram of PCB unknown unchanged with respect to standard PCB with no evidence of interferences.

Case II — EC gas chromatogram of PCB unknown altered with respect to standard PCB with no evidence of interferences.

Case III — EC gas chromatogram of PCB unknown unchanged with respect to standard PCB with evidence of interference.

The amount of PCB's in Case I samples is determined by preparing a plot of the major peak height vs. concentration; for Case II, a plot of the total sum of all major peaks vs. concentration. With Case III samples, a peak free from interference is used. When dominant interferences are present, one or more of the chemical clean up procedures is employed.

In all cases, the response of the electron capture detector must be linear for quantitative analysis.

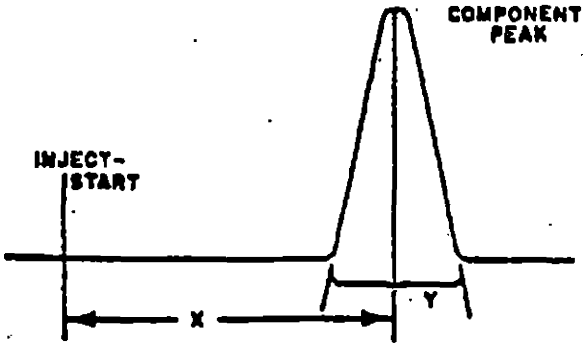
Contamination:

In determining PCB's in water, soil and sediment by electron capture gas chromatography, laboratory sources of contamination can be a major problem. The samples and extracts should never be allowed to come in contact with materials other than glass, Teflon or metal. Laboratory glassware should be thoroughly washed with hot, soapy water, rinsed with distilled water, acetone, and then hexane. All equipment should also be rinsed again with hexane just prior to use and blanks should be frequently carried through all steps of the procedures to insure against the possibility of contamination.

SENSITIVITY

Two parts per billion
Absolute sensitivity - 0.5×10^{-9} grams
Volume injected - 5 µl.
Final volume of extract - 5 ml.
Sample size - 250 ml.

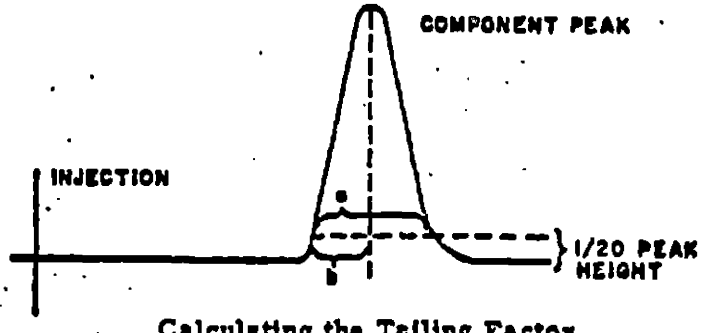
COLUMN PERFORMANCE INDICATORS



Calculating Column Efficiency

1. Theoretical Plates, N

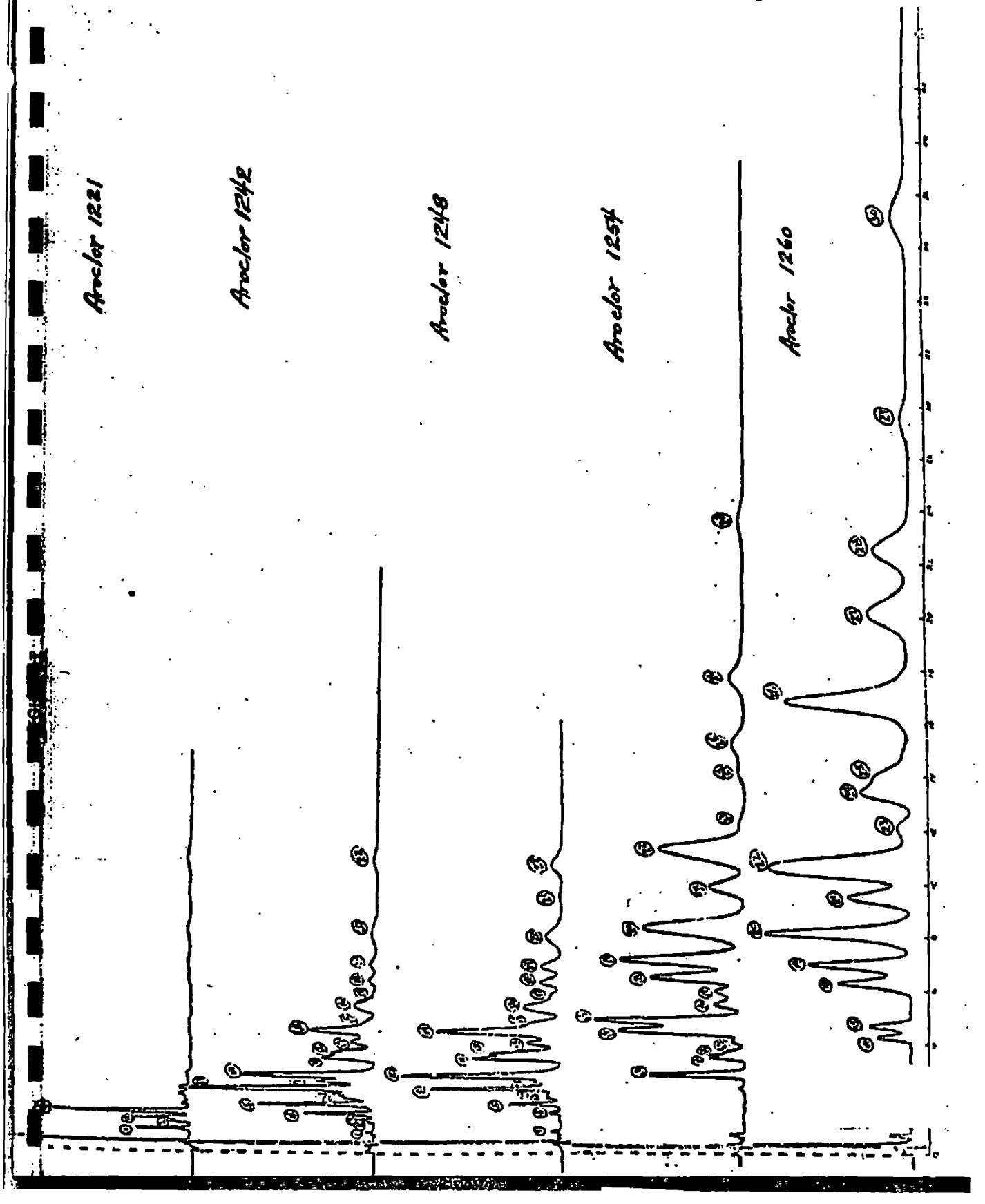
$$N = 16(x/y)^2$$



Calculating the Tailing Factor

2. Tailing, T

$$T = a/2b$$

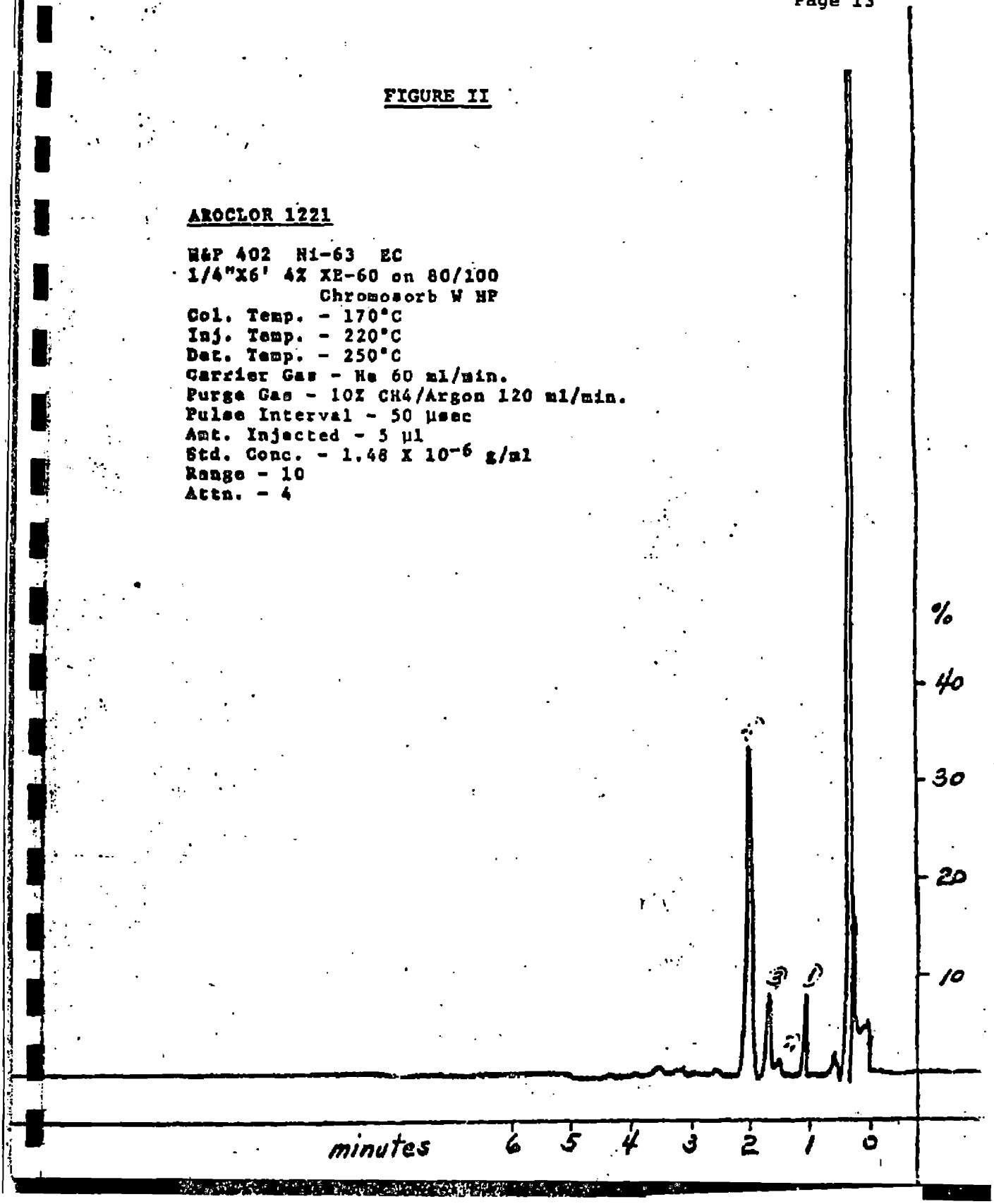


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FIGURE II

AROCLOR 1221

H&P 402 Ni-63 EC
1/4"X6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 170°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH4/Argon 120 ml/min.
Pulse Interval - 50 µsec
Amt. Injected - 5 µl
Std. Conc. - 1.48 X 10^{-6} g/ml
Range - 10
Attn. - 4



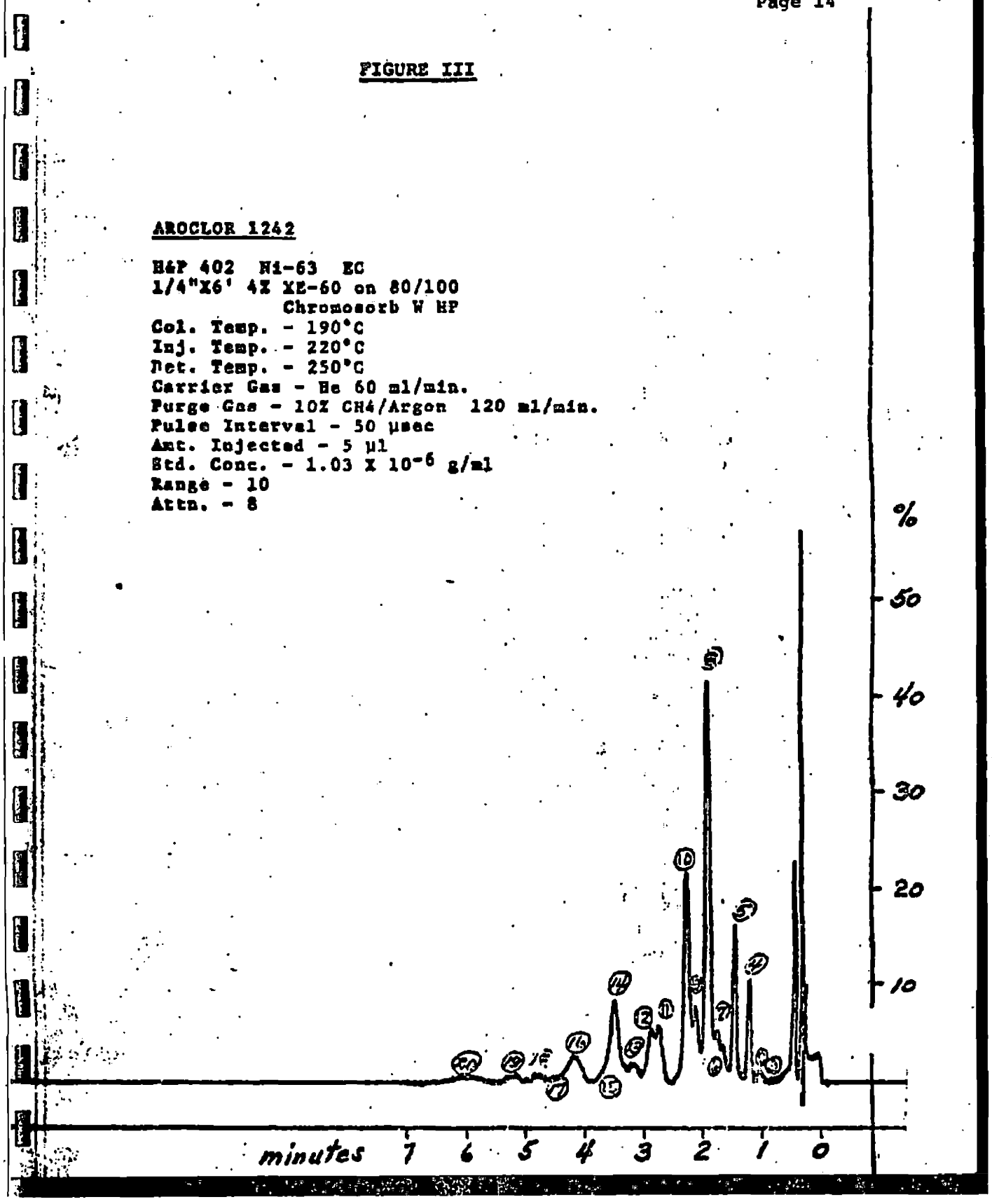
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FIGURE III

AROCLOR 1242

H&P 402 Ni-63 EC
1/4"X6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 190°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH4/Argon 120 ml/min.
Pulse Interval - 50 µsec
Amt. Injected - 5 µl
Std. Conc. - 1.03 X 10^{-6} g/ml
Range - 10
Attn. - 8

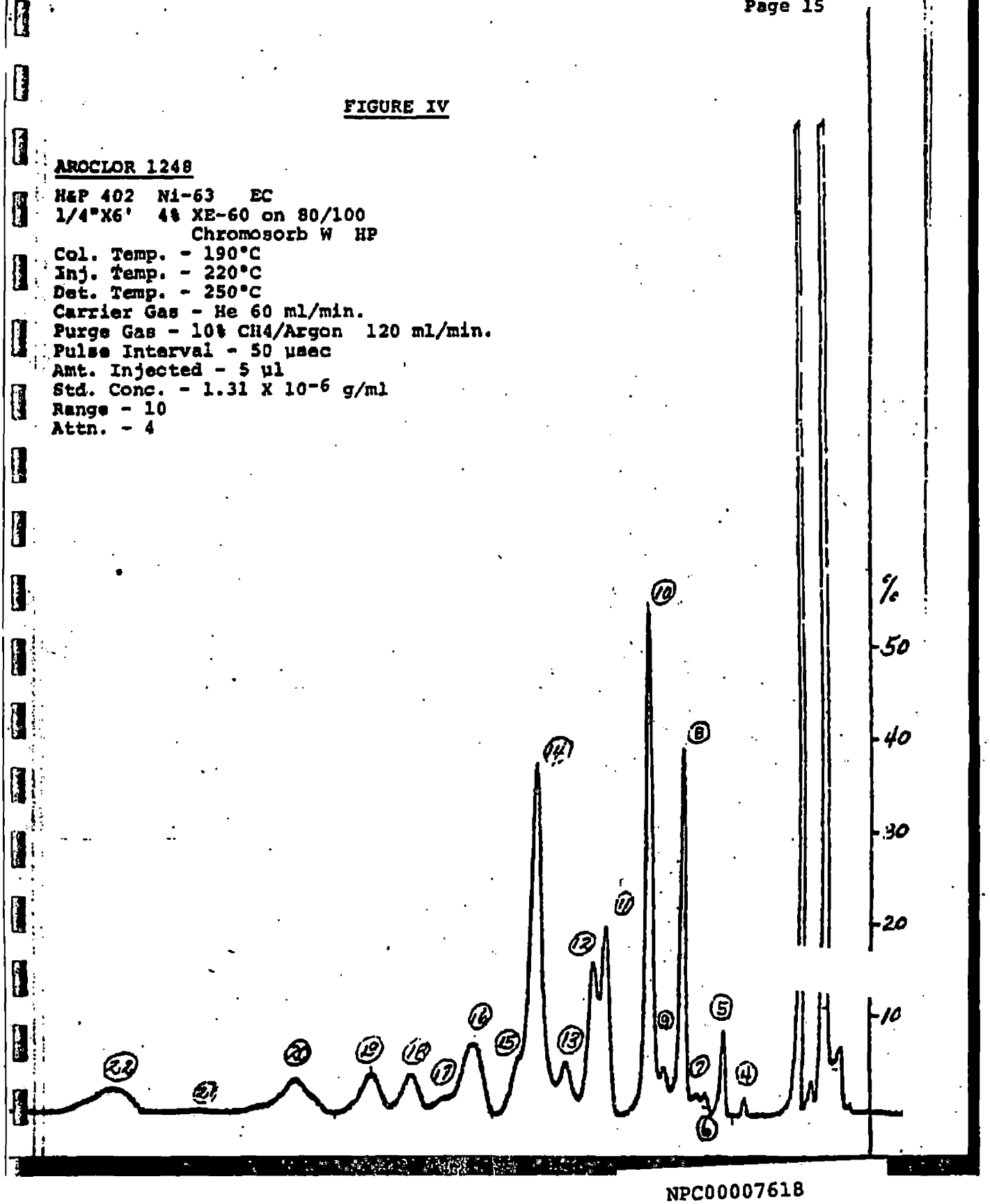


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FIGURE IV

AROCLOR 1248

H&P 402 Ni-63 EC
1/4"X6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 190°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH4/Argon 120 ml/min.
Pulse Interval - 50 µsec
Amt. Injected - 5 µl
Std. Conc. - 1.31 X 10^{-6} g/ml
Range - 10
Attn. - 4

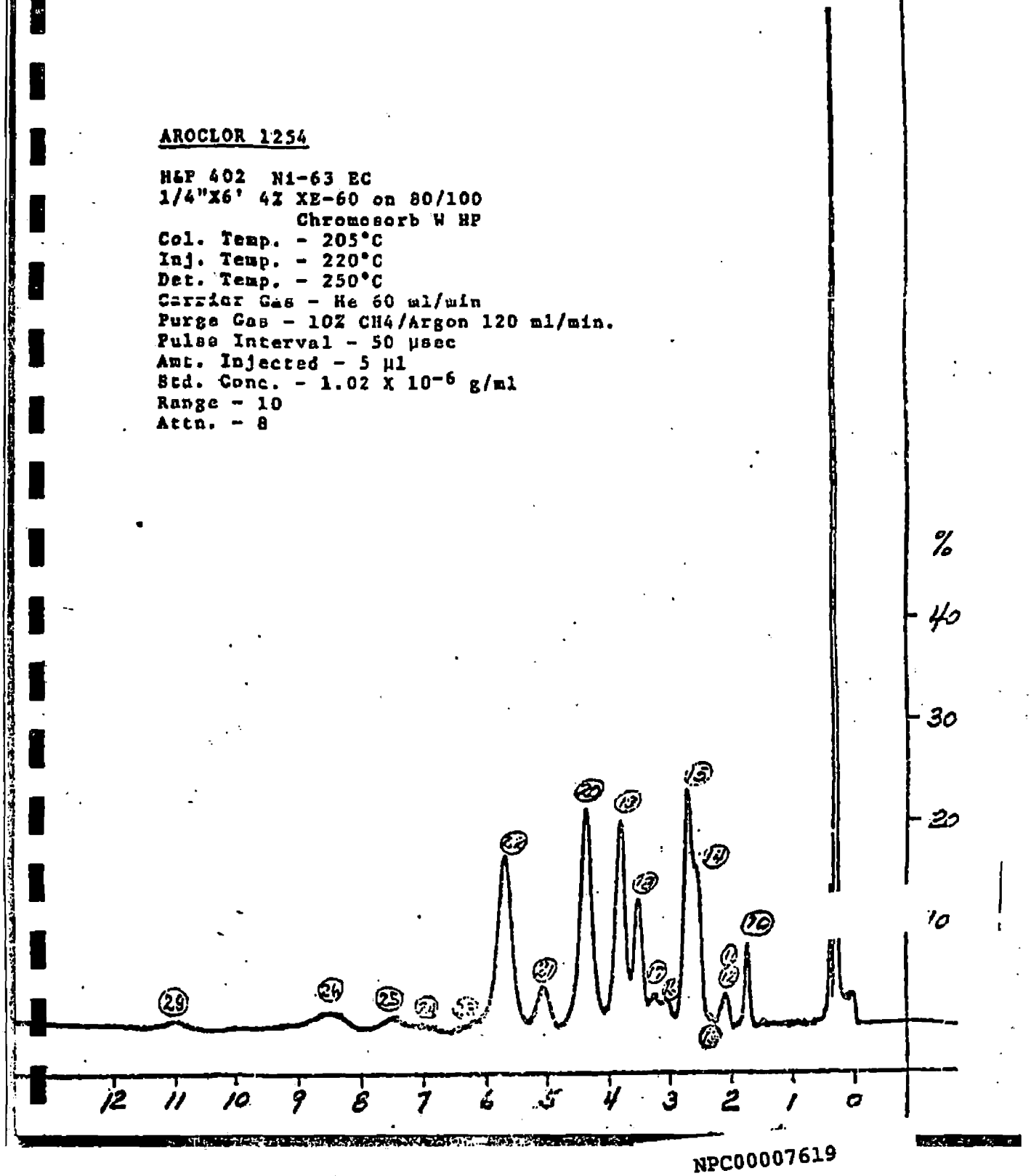


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FIGURE V

AROCLOR 1254

H&P 402 Ni-63 EC
1/4"X6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 205°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min
Purge Gas - 10% CH4/Argon 120 ml/min.
Pulse Interval - 50 µsec
Amt. Injected - 5 µl
Std. Conc. - 1.02×10^{-6} g/ml
Range - 10
Attn. - 8

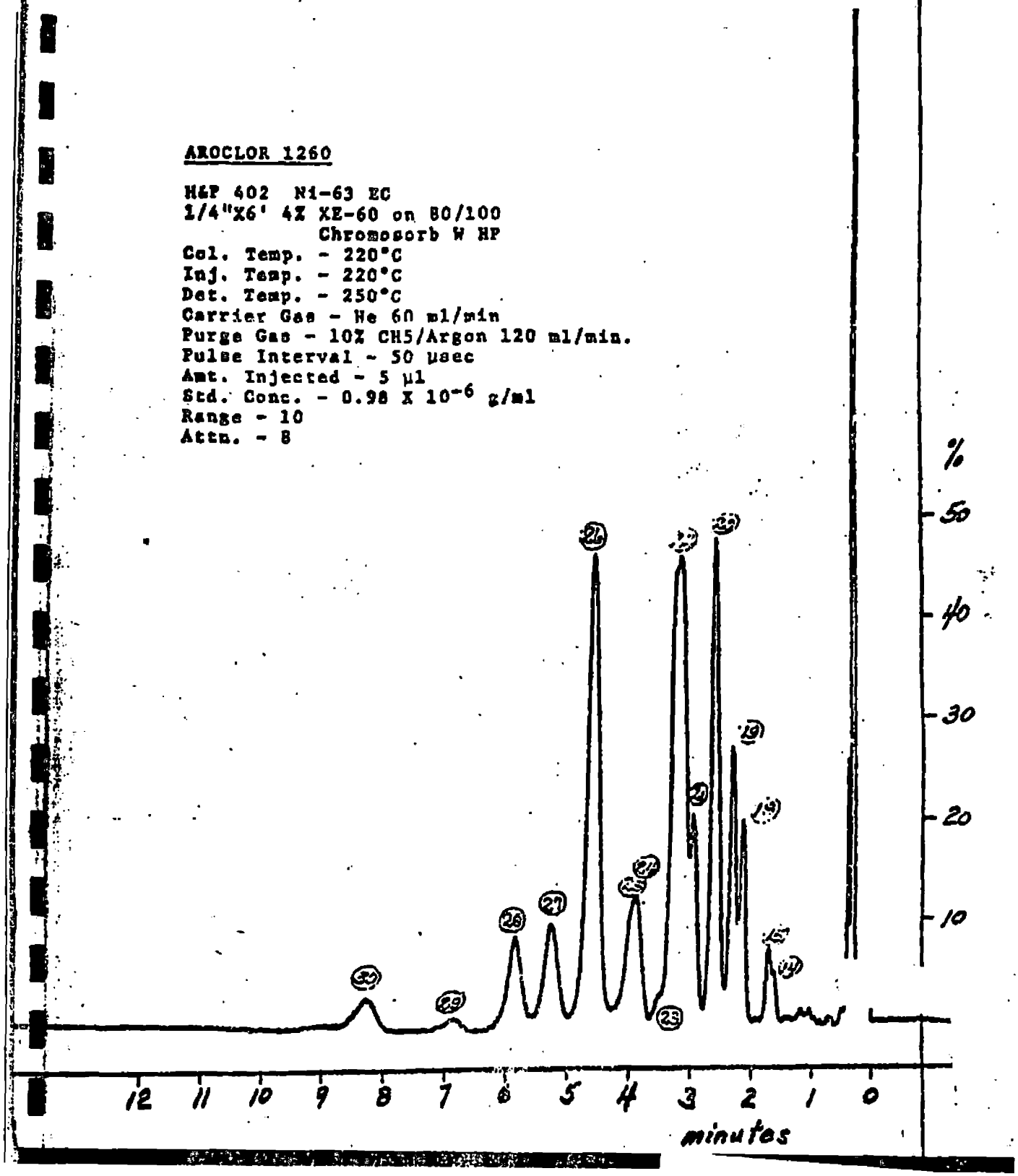


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FIGURE VI

AROCLOR 1260

H&P 402 Ni-63 EC
1/4"X6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 220°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min
Purge Gas - 10% CH5/Argon 120 ml/min.
Pulse Interval - 50 µsec
Amt. Injected - 5 µl
Std. Conc. - 0.98 X 10^{-6} g/ml
Range - 10
Attn. - 8



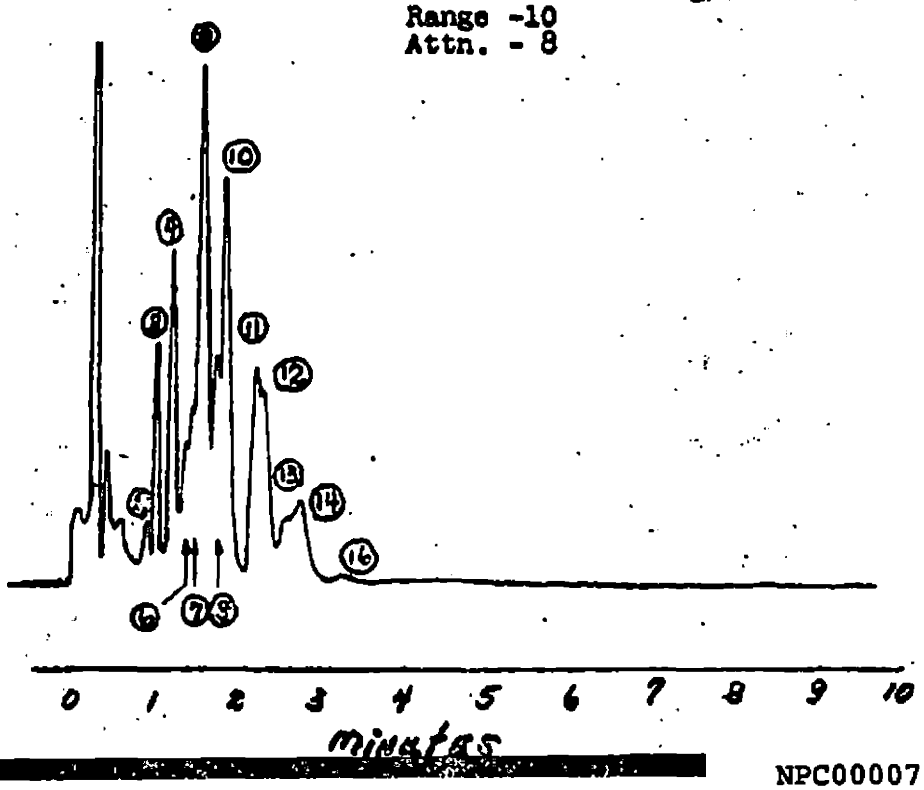
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FIGURE VII

AROCLOR 1016

H&P 402 Ni-63 EC
1/4"X6' 4% XE-60 on 80/100
Chromosorb W HP
Col. Temp. - 200°C
Inj. Temp. - 220°C
Det. Temp. - 250°C
Carrier Gas - He 60 ml/min.
Purge Gas - 10% CH_4/Argon 120ml/min.
Pulse Interval - 50 usec
Amt. Injected - 5 ul
Std. Conc. - 1 ug/ml.
Range -10
Attn. - 8



→ Mr. D M Sauter

PLB TY

Westinghouse Electric Corporation Power Systems

Distribution Apparatus Division
Box 341
Bloomington Indiana 47401
(812) 332 4421

October 22, 1976

Mr. J. J. Kark
NEMA
155 East 44th Street
New York, N.Y. 10017

Subject: Negative Ballot, Revised Document, ANSI C107.1 (197_)

Dear Sir:

There is a clear need to distinguish between "goals" and "requirements" particularly with respect to Sections 3.4, 3.4.1, 3.4.1.2, 3.4.1.4 and 4.1.5, 4.1.5.1, 4.1.5.3, 4.1.6.2.2.

Wording of the proposed standard (and in existing C107-1 1964) is acceptable as an expression of goals. However, some environmentalists and others have been inclined to read into this wording a present, mandatory requirement of zero molecules of PCB loss in water effluents. This seems unrealistic in view of the present general status of manufacturing operations, and inconsistent with the present general state of the environment (where statements are appearing that evidence of PCB's is found virtually everywhere). It also seems inconsistent with the probable tolerated levels to be established by the various governing organizations, and inconsistent with environmental need as reflected in the permissible disposal of apparatus, such as ballast capacitors, and the handling of losses by spills.

At the least, wording should be modified to specify present wording to be a goal, and losses in water effluent not to exceed those set by the governing regulatory agency.

In particular, specific changes should be made, as follows:

Clause 3.4.1, last sentence - add parenthetical phrase, "... no askarel wastes of any kind to be disposed of (in bulk) in any water effluent streams...", and add sentence, "Escape of small trace quantities of askarels shall be limited to that established by the appropriate governmental regulatory agency."

Clause 3.4.1.4: The "ideal approach" is described. It should be stated that ideal solutions to problems are extremely difficult - if not impossible - to achieve, and therefore a minimum acceptable solution to minimization of effluent stream contamination is therefore given. The following additional sentence is proposed: "As a minimum, effluent streams should have contaminated particulate matter

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separated for disposal, and concentrations of soluble askarels controlled by dilution or other means to levels consistent with limits established by the appropriate governmental regulatory agency."

In other respects, I favor approval of the revised document, C107.1 (197_).

Sincerely,

Robert D. McClain
NEMA Delegate to ANSI C-107

jg

cc: Mr. C. R. Willmore
NEMA
2101 L Street N.W.
Washington, D.C. 20037

NPC00007623

Engineering Department

May 23, 1972
PCB Situation, Brief

BLOOMINGTON WORKS

Mr. J. B. Brittain
Engineering Manager

1. EPA is moving to control PCB in plant effluents (5-14-72), based on 181 page report from a Federal task force (EPA, FDA, Department of Agriculture, National Oceanic and Atmospheric Administration, Bureau of Sport Fisheries and Wildlife, Whitehouse Council on Environmental Quality, Office of Science and Technology, and HEW). Methods of control and deadlines are not yet established.

2. ANSI C-107 working group meets in Chicago this week (Thursday, May 25) and present draft will probably be recommended to main committee.

3. Monsanto meeting here (on their new fluid) cancelled (because of illness of Dr. Munch).

4. Mr. McDonough plans a visit to Monsanto in St. Louis next week. (Contacts to DAD in establishing agenda have been through Purchasing, so far.)

5. Fluid #982: (a) Disclosure and patent application should be completed as soon as possible; (b) Life-test equipment at Hi-Potronics passed heat run and should be returned and reinstalled as soon as possible; (c) Additional units must be built and tested in the lab; (d) Field trial installations should be selected and put into operation, by September, if possible; (e) Environmental/hygienic studies should be completed by R&D.

6. Timing remains the most critical aspect of PCB control: DAD will be in a very critical position if EPA lifts the ANSI C-107 document (draft) and makes it their basis for regulation of the industry, effective in 90 days (or even 180 days); I do not think Bloomington will be ready. A Planning Board review, establishment of a task force, and agreement on a detailed time table should be considered for the first week of June.

R. D. McClain, Manager
Capacitor Unit Engineering

RDMcC:kb

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Instructions For Surge Protection Capacitors

Surge protection capacitors are designed to protect rotating machines and other equipment against surges by reducing the rate of rise of surge voltage when connected from line to ground at the machine terminals. These capacitors are sealed and require no additional protection from the weather under ordinary service conditions.

RECEIVING

When unpacked, carefully inspect the unit for damage and check the nameplate to be sure that the desired rating has been received. File a claim immediately with the carrier for any damage sustained in transit and obtain a carrier inspection report.

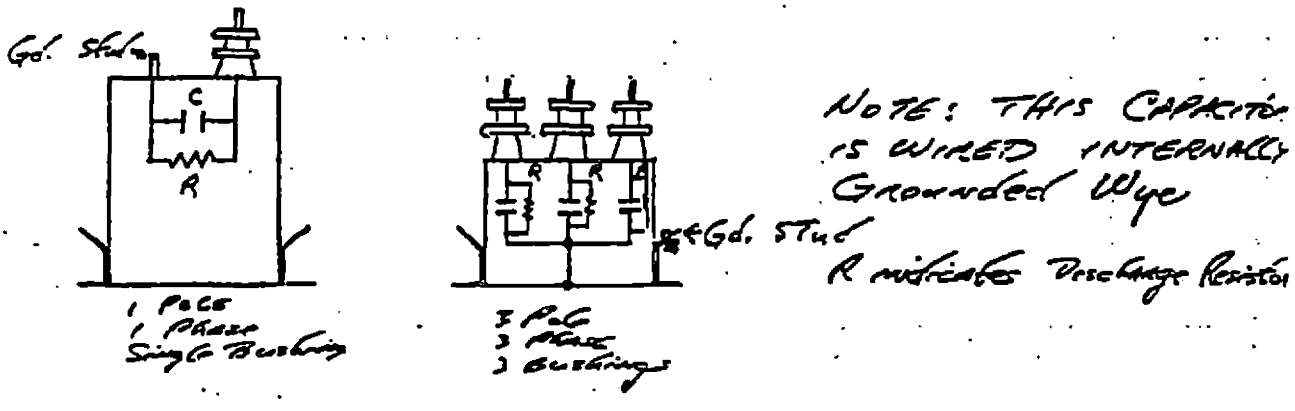
INSTALLATION

The maximum continuous operating voltage is 110% of the nameplate rating.

WHEN INSTALLING CAPACITORS, CHECK THE NAMEPLATE OF EACH UNIT TO SEE THAT IT HAS THE PROPER RATING FOR THE CIRCUIT.

The parallel groove connectors will accommodate any combination of two conductors from #12 solid to #1 stranded wire. Terminals should be tightened firmly, but avoid excessive force.

TORQUES OF MORE THAN 20 FOOT POUNDS ARE NOT NECESSARY OR RECOMMENDED.



MAINTENANCE

The capacitor should be inspected periodically after being placed in operation to be sure that it continues to operate properly. A slight bulge is common and

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should not be mistaken for a failure. Failed units are not always visibly detectable. Heat loss in the capacitor is dissipated by both convection and radiation. Therefore, under normal operation the capacitor will be warm. If a capacitor unit develops a minor leak (no more than a few drops) contact the nearest Westinghouse Office regarding the possibility of repair.

CAUTION

ALLOW FIVE MINUTES AFTER DISCONNECTING TO PERMIT THE CAPACITOR TO DRAIN THROUGH THE INTERNAL DISCHARGE RESISTOR. THEN FOR SAFETY, SHORT CIRCUIT THE TERMINALS BEFORE HANDLING.

DISPOSAL

THIS PRODUCT CONTAINS A POLYCHLORINATED BIPHENYL (PCB). TO AVOID POSSIBLE ENVIRONMENTAL CONTAMINATION, IT SHOULD BE DISPOSED OF ONLY IN SUPERVISED DRY LANDFILL AREAS MEETING STATE REQUIREMENTS OR IN INCINERATION FACILITIES DESIGNED FOR DISPOSAL OF PCB'S. SEE AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINE NO. C107.1-1974 (OR LATEST REVISION) FOR FURTHER INFORMATION. COPIES ARE AVAILABLE FROM AMERICAN NATIONAL STANDARDS INSTITUTE, 1430 BROADWAY, NEW YORK, NEW YORK 10018.

TRANSPORTATION TO THE DISPOSAL FACILITIES SHOULD BE IN CONTAINERS THAT WILL PREVENT LEAKAGE AND ACCIDENTAL LOSS OF ASKAREL TO THE ENVIRONMENT. CONTAINERS SHOULD BE LABELED AS TO THE CONTENTS AND PRECAUTIONS RELATIVE TO LOSS TO THE ENVIRONMENT.

WESTINGHOUSE ELECTRIC CORPORATION

Distribution Apparatus Division
Bloomington, Indiana 47401

MONSANTO INDUSTRIAL CHEMICALS COMPANY

WELCOMES

MR. M. J. MC DONOUGH

WESTINGHOUSE ELECTRIC CORPORATION

St. Louis, Mo.
June 1, 1972

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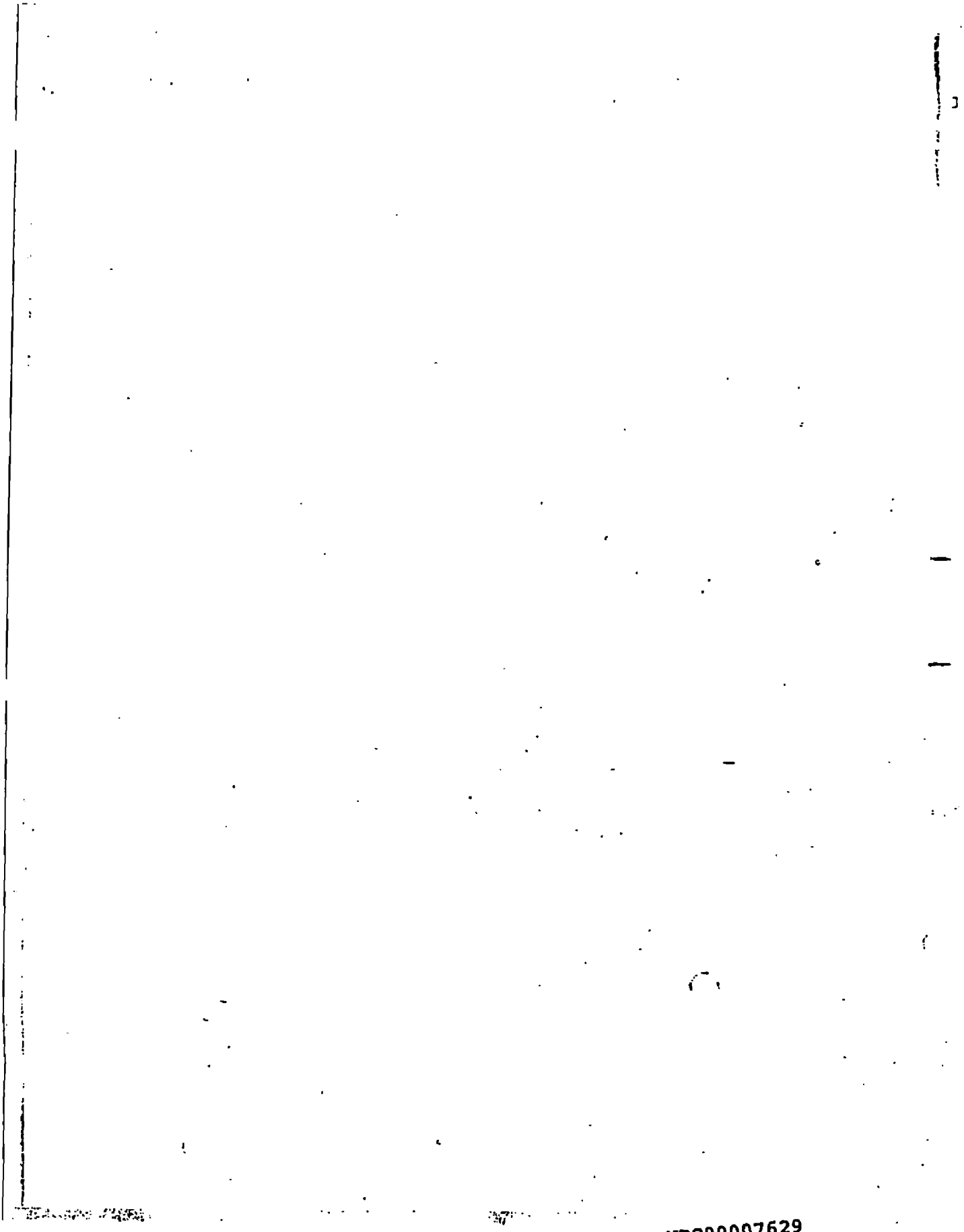
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MONSANTO INDUSTRIAL CHEMICALS COMPANY
SUMMARY POSITION ON DIELECTRIC AROCLORS

A) In view of the PCB ecological situation:

1) Monsanto decided to remain in the dielectric Aroclor business because of the electrical industry's need for these products based on their unique performance characteristics, and because industry supported Monsanto with special agreements of indemnification.

2) Monsanto has voluntarily phased out of many PCB markets and will sell only to approved dielectric customers. This decision was supported recently by the U.S. Government PCB Task Force.

3) Monsanto with industry cooperation developed a more environmentally acceptable capacitor fluid--Aroclor 1016.

4) Monsanto costs for dielectric Aroclors have increased because of:

- Lost sales volume/lower production divisor
- Pollution clean-up costs
- Research & development expenses on new products
- Toxicity, biodegradation test work
- Plant investments

5) Monsanto has had (since 1969) a research and development program to find "PCB" substitutes in the dielectric area:

- To date some promising leads
- A capacitor experimental sample
- Transformer Fluid - no candidates as yet
- At least 2-3 years away from commercialization

6) On balance, the ecological risks have been substantially reduced by Monsanto and customer actions.

B) Monsanto has long valued our relationship with Westinghouse and we desire to work closely with you at all Management.

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WESTINGHOUSE PURCHASES

OF

CAPACITOR AND TRANSFORMER INERTEENS

POUNDS

LOCATIONS	1968	1969	1970	1971	1972 Est[3]
Bloomington, Ind.	3,610,000	2,724,000	2,557,980	1,032,600	2,046,000
Total Capacitor Inerteen	3,839,000[1]	2,724,000	2,566,380[2]	1,051,650[2]	2,100,000[2]

Notes: 1) Includes small sales to Vicksburg
2) Includes small sales to Cleveland
3) Annuallized, from first four months

Sharon, Pa.	5,873,000	2,596,000	2,244,520	1,213,000	270,000
So. Boston, Va.	--	2,051,000	3,469,120	4,083,000	3,927,000
Phoenix, Ariz.	--	237,000	323,900	225,000	270,000
Service Shops	1,003,000	740,300	1,399,866	285,000	393,000
Total Transformer	6,876,000	5,624,300	7,437,406	5,806,000	4,860,000
Total Westinghouse	10,715,000	8,348,300	10,003,786	6,857,650	6,960,000

Historical Price of Capacitor Aroclor Sold To Westinghouse

Year	Price Per Pound (Bulk)	Product
1953	14.0¢ Not Delivered	Aroclor 1242
1957	13.88¢ Delivered	Aroclor 1242
1960	14.98¢ Delivered	Aroclor 1242
1964	14.50¢ Delivered	Aroclor 1242
1966	14.95¢ Delivered	Aroclor 1242
1970	15.00¢ Delivered	Aroclor 1242
1971	18.00¢ Delivered	Aroclor 1016
1972	20.50¢ Not Delivered	Aroclor 1016

Historical Price of Transformer Inerteen Sold To Westinghouse Electric Company

Year	Price Per Pound (Bulk)	Product
June 1968	13.45¢ Not delivered	Inerteen 54201CM (100% Aroclor 1242)
Jan 1, 1971	16.50¢ Not delivered	"
April 1, 1972	19.50¢ Not delivered	"

Year	Price Per Pound (Bulk)	Product
July 1, 1970	14.70¢ Not delivered	Inerteen 54201 KA (70% Aroclor 1254 + 30% TCB)
Jan 1, 1971	16.70¢ Not delivered	"
April 1, 1972	21.00¢ Not delivered	"

MONSANTO DIELECTRIC FLUIDS

Pricing Characteristics

1. Unusual price stability until 1970 even though ---

   Cost Increases

Labor Costs:	197% Increase	(1953-1972)
Raw Materials:	20% Increase	(1953-1972)
Indirect Fixed Costs:	41% Increase	(1953-1972)

   (e.g. Capacitor Fluids increased by only 7%, 1953-1969)

2. Increase 1970 - 1973 due to:

   A. Successful Development of Aroclor 1016

   B. Loss of 45% PCB Sales to other markets -- Divisor loss.

   C. Costs of Environmental Control Programs ---

      Incinerator Program

      Plant Clean-up

MONSANTO PRESENTATION TO FEDERAL GOVERNMENT PCB TASK FORCE

MAY 15, 1972

OBJECTIVES

- PROGRESS REPORT ON LABORATORY BIODEGRADATION OF PCB'S
- RESIDUE ACCUMULATION STUDIES IN FISH, BIRDS AND MAMMALS
- TO SHOW REDUCTION IN LESS BIODEGRADABLE PCB'S AS A RESULT OF MONSANTO ACTIONS ON SALES AND PRODUCTS

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MONSANTO PCB ACTIONS

- PHASE-OUT OF PCB SALES WORLDWIDE IN ALL APPLICATIONS EXCEPT DIELECTRICS
- CONVERSION OF DIELECTRIC FLUIDS TO MORE BIODEGRADABLE PCB'S

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MONSANTO PCB SALES IN U.S.A.

(MILLION POUNDS)

	DIELECTRICS	ALL OTHERS	TOTAL
1969	37.0	30.0	67.0
1970	40.5	33.5	74.0
1972 (EST.)	32.0	--	32.0

(3)

EFFECT OF PHASE-OUT POLICY

PCB SALES REDUCED IN U.S.A. BY

30 TO 33 MILLION POUNDS.

OR 45%

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PCB PRODUCT
CHANGES IN DIELECTRICS

CAPACITORS

97% CONVERSION TO AROCLOR 1016

TRANSFORMERS

ELIMINATION OF AROCLOR 1260

DEGREE OF BIODEGRADATION OF PCB'S

BASED ON DATA PRESENTED

- TRANSITION IN BIODEGRADATION OCCURS AROUND PENTA-/HEXA-CHLOROBIPHENYL
- DISAPPEARANCE OF ALL HOMOLOGS BELOW HEXA-CHLOROBIPHENYL OBSERVED
- PENTA- AND HIGHER PCB DETERMINED BY SPECIFIC GLC/MS TEST METHOD

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PCB'S USED IN

PCB	MAJOR USE PERIOD
AROCLOR 1254	1930-1952
AROCLOR 1242	1952-SEPT. 1971
AROCLOR 1016	OCT. 1971

CAPACITORS

% PCB (PENTA-CHLORO- AND HIGHER	% PCB (HEXA-CHLORO- AND HIGHER
77.0	29.0
9.0	1.0
1.1	0.1

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CAPACITOR FLUIDS
WHY CONVERT TO AROCLOR 1016 ?

- 9-FOLD REDUCTION IN PCB'S OF PENTACHLORO- AND HIGHER
- 10-FOLD REDUCTION IN PCB'S OF HEXACHLORO- AND HIGHER
- MINIMUM INDUSTRY TESTING REQUIRED

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CAPACITOR FLUIDS
WHAT IS THE EFFECT OF AROCLOR 1016?

U.S. CAPACITOR FLUID SALES (1972):~20 M LBS.

IF AROCLOR WAS	% PENTACHLORO- AND HIGHER PCBs WOULD BE:*	% HEXA CHLORO- AND HIGHER PCBs WOULD BE*
1254	15,400,000 POUNDS	5,800,000 POUNDS
1242	1,800,000	200,000
1016	220,000	20,000

*THIS DOES NOT MEAN AMOUNTS OF PCB ENTERING THE ENVIRONMENT

WHAT IS CAPACITOR FAILURE RATE?

INDUSTRY SOURCES CITE : 0.02-0.2% PER YEAR

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IF CAPACITOR FAILURE RATE IS 0.2% PER YEAR (WORST CASE)

PCB ESCAPE TO THE ENVIRONMENT* IS --

	AROCLOR 1242	AROCLOR 1016
ALL PCB HOMOLOGS	40,000 POUNDS	40,000 POUNDS
PENTA CHLORO- AND HIGHER	3,600	440
HEXA CHLORO- AND HIGHER	400	40

*ASSUMES U.S. FLUID SALES OF 20 M LB./YEAR

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PCB CHANGES IN TRANSFORMER FLUID APPLICATIONS

- AROCLOR 1260 BEING PHASED-OUT NOW
- INCINERATION OF SCRAP PCB'S - 1971

NOTE: ASKAREL (PCB) TRANSFORMERS ARE TIGHTLY SEALED UNITS

WHAT IS FAILURE RATE IN LIQUID TRANSFORMERS?

INDUSTRY SOURCES CITE: UNDER 0.2% PER YEAR*

*ALL LIQUID TYPES - MINERAL OIL AND PCB.

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IF ASKAREL (PCB) TRANSFORMERS FAIL AT 0.2%/YEAR HOW MUCH PCB IS AFFECTED*?

ALL PCB HOMOLOGS 24,000 LBS.

(ESTIMATED PCB TRANSFORMER FLUID SALES IN U.S. 12 M LBS./YEAR)

*WITH INCINERATION FACILITIES AVAILABLE, NOT ALL THESE AMOUNTS WILL ENTER ENVIRONMENT.

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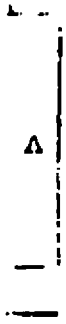
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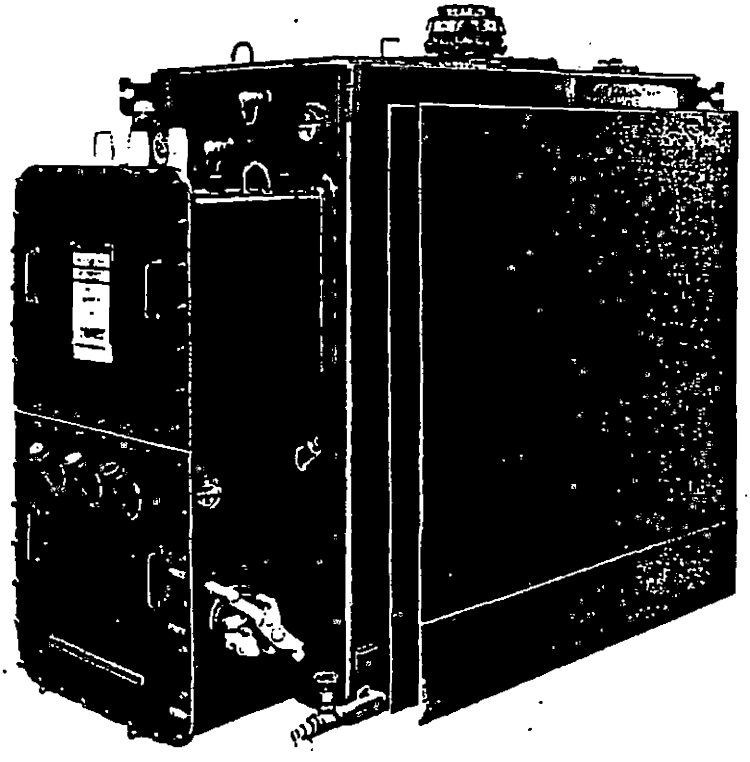
MONSANTO'S PRESENT PROGRAM TO PREVENT ENVIRONMENTAL POLLUTION BY PCB'S

- NO MORE SALES WORLD-WIDE EXCEPT APPROVED DIELECTRIC USERS
- RESTRICT OVER 97% CAPACITOR FLUID SALES TO AROCLOR 1016 ONLY
- ELIMINATE AROCLOR 1260 FROM TRANSFORMER FLUIDS
- CONTINUE INCINERATION FACILITIES FOR SCRAP PCB'S
- ENCOURAGE DIELECTRIC INDUSTRY THROUGH ANSI C-107 TO ENFORCE STRICT ENVIRONMENTAL CONTROL OVER PCB'S



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INSTRUCTION BOOK NT 1001
FOR
PART I NETWORK TRANSFORMERS



Westinghouse Electric Corporation
Small Power Transformer Division
South Boston, Virginia

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SECTION I TRANSFORMER

INTRODUCTION

These instructions cover the installation, accessories and maintenance of Network Transformers. The Network Transformer is shipped filled with insulating liquid and as completely assembled as possible.

Additional Instructions

Copies of instruction leaflets referred to but not included in this booklet can be obtained by contacting your Westinghouse Sales Office.

RECEIVING

All transformers are carefully tested at the factory and are in good condition when shipment is made. However, upon receipt inspect the transformer, packages and parts for possible shipping damage. Also, check the bill of lading for possible shortages. If the inspection indicates a shortage, damage or evidence of hidden damage, it must be reported to the carrier's representative and to a Westinghouse representative before unloading the transformer.

CHECK LIST

External Inspection of Transformer

Blocking and Tie Rods

1. Are all tie rods or chains undamaged and nuts tight?
2. Is all blocking tight and in good condition?
3. Is there any evidence of load shifting in transit?

Transformer Tank and Fittings

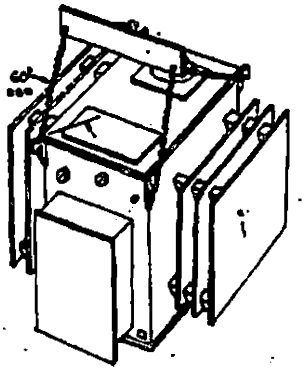
4. Are there indications of external damage?
5. Is the paint finish damaged?
6. Are all fittings which were shipped attached still in place and undamaged?
7. Is there any evidence of liquid leakage?

HANDLING

Transformers must be handled in the normal upright position unless instructions have been received to the contrary.

Lifting hooks or eyes are provided for crane lifting. When the transformer is lifted, all hooks or eyes must be used. Guides for lifting are contained in the following table.

Chain Size (in.)	No. of Chains Req'd.	Chain Capacity (lbs.)**	Chain Sling Without Spreader Bar	Capacity (lbs.*) With Spreader Bar
1/4	4	3,250	8,400	11,200
3/8	4	6,600	17,100	22,800
1/2	4	11,250	30,000	40,000
5/8	4	16,500	43,500	58,000
3/4	4	23,000	60,000	80,000
7/8	4	28,750	75,000	100,000



*Lifting capacity is the smaller of:
1. Spreader bar capacity.
2. Chain sling capacity.

**ASTM Specifications for alloy-steel chains.

***60° Angle is smallest angle recommended with or without spreader bar.

Similarly, jacking areas are provided for lifting the transformer with jacks. All such areas must be used when the transformer is to be jacked.

Check the outline drawing for any required special equipment or procedures to be used in lifting.

Never attempt to lift the transformer by using cranes or jacks on any part of the transformer other than the lifting hooks or jacking areas provided for this purpose.

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When the transformer is supplied with removable terminal chambers or Network protectors, these may be detached to facilitate lowering the tank into a vault.

STORAGE

It is advisable to store the transformer, completely assembled, at its permanent location. In any case, the transformer should be placed on a level, solid foundation. The box containing accessory parts should be stored indoors in a dry location.

When stored for long periods, it is recommended that the space above the oil be pressurized with dry air or nitrogen to two or three psig. Then periodic inspections as listed in Section I Maintenance should be made.

Before placing the transformer into service, all checks and inspections listed under "Installation" should be made.

INSTALLATION

Location

The Network Transformer should be placed on a foundation which need only be strong enough to support its weight safely.

Ventilation

Self-cooled Network Transformers depend entirely upon the surrounding air to carry away their heat. For this reason care must be taken to provide adequate ventilating facilities.

Natural ventilation is the basic ventilation system used for Network Transformer vaults and is the most dependable. The amount of heat dissipated through the vault walls and the necessary grate openings to remove the heat loss can be calculated by various methods. However, a simplified method for an approximate determination of net grating area is generally accepted. The National Electric Code 1975 recommends three square inches of *net* grating opening for both the air inlet and outlet for each KVA of transformer capacity. The grating is located in the vault roof.

Connections

WARNING: **DO NOT CHANGE CONNECTIONS ON A TRANSFORMER THAT IS UNDER EXCITATION, NOR MAKE ANY CONNECTIONS EXCEPT AS AUTHORIZED BY THE NAMEPLATE OR CONNECTION DIAGRAM.**

Line connections must be made without placing undue stress on the bushings.

Check tap changer mechanism (See Tap Changer located in the Accessory section of the booklet) to make sure that the tap changer connection is proper for the required voltage. Changes in tap connections must be done *ONLY* with the transformer *DEENERGIZED*. The transformer is normally shipped with the tap changer set for the rated voltage.

A secure, effective low resistance ground is essential for protection. The transformer must be grounded permanently by connecting a heavy ground cable to the ground pad located at the bottom of the tank.

WARNING: **A POOR GROUND MAY RESULT IN LOSS OF LIFE OR DAMAGE TO THE EQUIPMENT.**

When a transformer is specially designed for use on a system having a solidly-grounded neutral, be sure that the neutral lead is permanently and solidly-grounded without resistance - refer to the nameplate.

Pressure Test

To check the integrity of the unit, introduce dry nitrogen or air through the pressure test fitting until a positive internal pressure is established. Allow the tank to stand for a period of one to two hours, then examine the tank and fittings for leaks. A leak above the liquid level can be located by applying a leak check solution to all joints, pipe fittings and cable connections.

Upon completion of the pressure test, the internal pressure must be relieved from the tank.

Insulating Liquid Test

Test liquid as described in Maintenance Section I of this booklet. The dielectric strength should be 26 KV or higher.

Final Inspection

Before energizing the transformer, these final checks should be made.

Electrical inspections should show that:

1. The electrical connections have been properly made (phasing, etc.).

2. The tap changer is positioned correctly.

3. All accessory contacts are operational.

4. All connections are tight and secure.

5. No grounding of the windings exists. A 1000-volt Megger test and a power factor reading should be made.

6. The correct transformer ratio exists.

7. There is continuity in all windings.

8. The neutral and ground connections have been made properly.

An external inspection is recommended to determine that:

1. Paint scratches have been refinished.

2. Bushings are clean.

3. The liquid level is proper.

4. The accessories are working correctly.

5. All tools or other objects have been removed from the transformer.

6. All handhole covers are tightly secured.

7. The mechanical relief device, when present, is reset.

8. The transformer holds pressure.

Internal inspections are normally not required. However, should one be made, the following items should be checked:

1. Evidence of moisture.

2. All bolting to assure that they are tight.

3. The tap changer linkage for operation.

4. Damage due to shifting.

ACCESSORIES

Magnetic Type Liquid Level Indicators

The liquid level indicators are self-contained, submersible, float-operated and welded to the transformer and switch cases. When specified, alarm contacts are supplied. The contact ratings are given in Table I. Refer to the wiring diagram or outline drawing for the connection schematic.

Table No. 1

Voltage	Non-Inductive Load-Amps	Inductive Load Amps.*
125 AC	10	10
250 AC	5	5
125 DC	0.5	0.05
250 DC	0.25	0.025

*L/R equal to or less than .026".
L = Inductive in henrys.
R = Resistance in ohms.

For indicators installed at the factory, the tank is filled to the level which corresponds to a liquid temperature of 25°C which is considered the normal level. Should the tank be filled at some temperature other than 25°C, use Table No. 2 to determine the variation above or below the normal level. If these allowances are not made, excessive pressure may be built up in sealed tanks.

Table No. 2

Average Liquid Temp. (°C)	Correct Filling Level (Percent of Scale Above or Below 25°C Level)
85 (High)	100
70	75
55	50
40	25
25 (Normal)	0
10	-33
-5	-67
-20 (Low)	-100

If any part of the instrument is damaged, the bezel may be replaced without disturbing the rest of the instrument and without loss of liquid.

Liquid Temperature Indicators

The temperature indicator is usually located on the HV end of the tank. It may be furnished with or without alarm contacts. In either case the indicator is submersible. The temperature element is mounted in a leak-proof well, permitting removal of the thermometer without lowering the liquid level.

The device is furnished with a red pointer which shows the highest temperature attained since last reset. The red pointer may be reset by wiping the magnet, attached to the thermometer case, across the face of the dial.

The micro-switch in the indicator with alarm connections is factory set to operate at 90°C. The switch is adjustable over a range of 65°C to 100°C. The switch opens at 7 1/2°C ± 2 1/2°C less than the closing temperature. The ratings for this switch are given in Table No. 1. Refer to the wiring diagram or outline drawing for the connection schematic.

Pressure Relief Device

Inerteen®-filled Network Transformers are normally provided with a mechanical pressure relief device. The device is located on the cover of the transformer. Should the pressure rise above the setting, a diaphragm will lift allowing the pressure to relieve. After the pressure returns to normal, the diaphragm will reset and reseal the transformer.

If contacts are provided, refer to Table 1 for the contact ratings and see wiring diagram or outline drawing for connection schematic.

Tap Changer

The tap changer in a Network Transformer is designed for *DEENERGIZED OPERATION ONLY*. The tap changer operating mechanism is located inside the transformer tank and is accessible through a two-inch pipe plug opening in the cover. See Figure 1. The mechanism is operated by a special wrench.

After removing the pipe plug, the special wrench is inserted with its flat side adjacent to the position indicator. The wrench is then turned one complete revolution for each tap position change until the desired position is reached.

WARNING: TAP CHANGER HAS STOPS AT THE MINIMUM AND MAXIMUM TAP CHANGER POSITIONS AS INDICATED ON THE NAMEPLATE. DO NOT FORCE TAP CHANGER AT THESE POSITIONS.

After removing the wrench, a thread sealant, such as liquid Teflon, should be applied to the pipe plug threads and the plug should be securely tightened.

DO NOT OPERATE TAP CHANGER WHILE TRANSFORMER IS ENERGIZED.

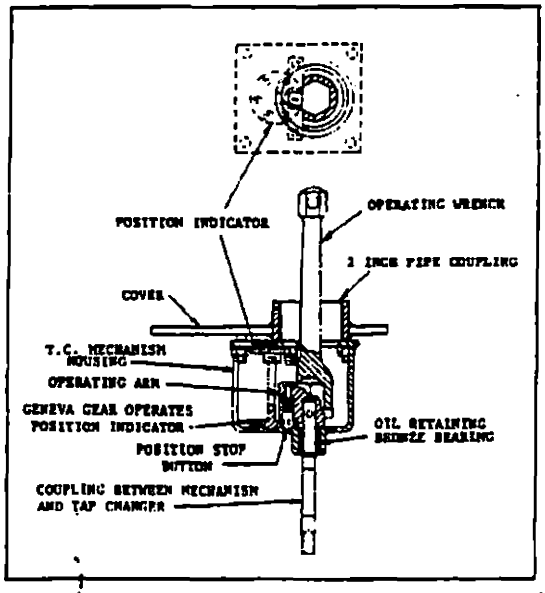


Fig. 1 *Outline of Type WSS Tap Changer with Operating Mechanisms Mounted Under Pipe Plug on Cover. (Looking Down, Internal Position Indicator is on Position One)*

Low Voltage Bushings

The LV bushing is a rolled flange, welded-in, Type RFW bushing. A cross-section of this bushing is shown in Figure 2.

Should maintenance be required due to damage, refer to I.L. 47-061-2, "Instruction for Inert-Arc Welded Bushing, Type RFW", which can be obtained through the nearest Westinghouse Sales Office.

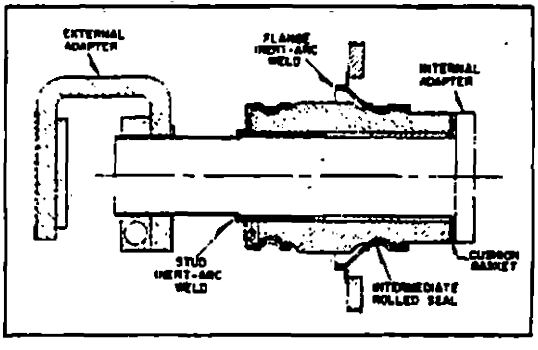


Fig. 2 *Bushing Cross-Section*

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MAINTENANCE

Periodic Inspection

Periodic inspections are essential to insure that the Network Transformer gives trouble-free service. The following inspections should be done on a regular basis.

1. Liquid Dielectric Test. It is recommended that a liquid sample be taken periodically and tested. The dielectric strength of new liquid should not drop below 26 KV as determined by the American Society of Testing Materials techniques. If the dielectric drops below 22 KV, the liquid should be filtered. Sampling and testing procedures can be found in I.B. 45-063-100 and I.B. 45-063-99.

2. Check all gauges. The liquid, depending on the temperature, should be at the proper level. Low liquid level can affect the transformer's ability to cool itself and can expose "live" parts causing flashover to ground or other "live" parts.

The maximum temperature indicator should be checked to see that the liquid temperature is operating within normal limits.

3. Check the tank for leaks. Inspect and tighten all bolted joints.

4. The paint finish should be checked periodically. See "Finish."

5. Switch Operation. See Switch section.

Sampling of Insulating Liquid

Care should be taken to procure a sample which fairly represents the liquid in the tank. A sufficient amount of liquid should therefore be drawn off before the sample is taken to insure that the sample will not be that which is stored in the sampling pipe. If the sample taken contains free water, it is not suitable for dielectric test and the sample should be discarded. A second sample should then be taken after at least two quarts of liquid have been withdrawn. If free water still exists, the liquid should be run through a blotter filter press and re-tested for dielectric strength.

The sample of the liquid should be taken when the unit is warmer than the surroundings to avoid condensation and should also be taken only on clear days.

When sampling *OIL* from the transformer, the sample must come from the bottom of the tank. It is recommended that a 16-ounce amber glass container be used as a sampling receptacle so that any water present may readily be seen.

When sampling *INERTEEN* the sample must come from the top liquid level. Use only tin containers with screwed metal caps or glass bottles with Inerteen-resistant stoppers. Always use all-metal hose or pipe when handling Inerteen.

Caution: Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor, particularly when hot, should be avoided. The eyes, nose and lips are affected when Inerteen comes in contact with them. All safety precautions must be observed when handling Inerteen.

Additional Information

Additional information concerning handling, sampling, filtering, testing and reconditioning can be obtained by ordering Instruction Book 45-063-100 for OIL and Instruction Book 45-063-99 for INERTEEN through the nearest Westinghouse Sales Office.

Disposal of Inerteen

See American National Standards Institute Guidelines C107.1-1974 for complete information on handling and disposal of Askarels. Copies are available from: ANSI, 1430 Broadway, New York, N.Y. 10018.

Collect all scrap Inerteen liquid in a suitable metal container which can be satisfactorily sealed. Once the Inerteen is collected, it may be returned in sealed drums or tank cars to Monsanto or other certified disposal company. Ship prepaid to:

Monsanto Company
W. G. Krummrich Plant
Sauget, Illinois
Attn: Supervisor Dept., 246

Nuclear Engineering Co.
Disposal Division
Sheffield, Illinois

Chem-Trol Pollution Serv., Inc.
4818 Lake Avenue
Blasdell, N.Y. 14219

Rollins-Purle, Inc.
Box 3349
Wilmington, Del. 19899

A charge will be made for all returned Inerteen.

Solvent rinses or other liquids contaminated with Inerteen should also be collected in sealed drums or tank cars and sent either to Monsanto or other certified disposal company.

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All solid materials contaminated with Inerteen must be stored in impervious containers until disposal. This includes all glass, metals, papers, insulation, clay rags, filter cartridges, etc.

These materials may be incinerated if suitable arrangements can be made for it to be done at a temperature sufficient to breakdown the Inerteen. Or they may be purged by cleaning with a proper fluid and the resultant fluid then may be incinerated using an approved procedure and temperature.

The following disposition is recommended for various materials.

Material	Disposition
Absorbing clay, filter paper, cartridges, sawdust and rags	Incinerate
Coils	Solvent Clean or Incinerate
Cores	Solvent Clean
Tanks & Frames	Solvent Clean
Copper or Aluminum	Solvent Clean
Insulation	Incinerate

Incineration

Incineration, whether of liquids or contaminated solid materials, must be done at a temperature of at least 2250°F and the stack must be equipped with a suitable scrubber to remove HCl.

Cleaning

The cleaning of drums which have contained used Inerteen requires great care in order to insure a thoroughly clean drum.

It is preferable to return such drums to the supplier where adequate cleaning facilities are available, rather than to attempt to clean them.

If it is necessary to clean such drums, the following procedure is recommended:

Rinse the drum thoroughly with gasoline or petroleum distillate, using about one-gallon each time, until the solvent shows no discoloration after using. Allow it to drain, then pump out the last traces of solvent with a vacuum pump, using a brass pipe flattened at the lower end to explore the corners of the drum. Collect all solvent rinse material for disposition as described above.

Caution: Do not use a steel pipe because of the danger of a spark igniting the gasoline or petroleum distillate vapor.

Next, heat the drum with bunghole down in a ventilated oven at a temperature of at least 88°C. (190°F) for sixteen hours. (A simple oven for this purpose may be made from sheet metal and heated with steam or an electric heater.) Blow out the drum with dry nitrogen or dry air to remove any lingering explosive vapors. Screw the bung on tightly before removing the drum from the oven. Use a new washer with the bung to insure a tight seal.

Caution: Open flames must always be kept away from the oven to prevent igniting inflammable gases which might be remaining in drum when placed in the oven.

The practice of refilling drums with Inerteen is undesirable and should be avoided whenever possible, for unless the utmost precautions are taken, the Inerteen is likely to become contaminated.

Drying of Transformer

Occasionally, moisture will be absorbed in the windings and insulation which the filtering process will not remove. A recommended method of drying the windings and insulation is by circulating current through the windings. The LV winding should be short-circuited and sufficient voltage impressed across the high voltage winding to circulate enough current through the coils to maintain the coil temperature at 80°C to 90°C as measured by winding resistance. About one-fifth of normal full-rated current is generally sufficient to do this. The impressed voltage necessary to circulate this current varies within wide limits among different transformers. This voltage will generally be approximately 1/2 percent to 1-1/2 percent of the normal voltage of the winding at normal frequency.

The transformer should be placed in its case with the liquid and with the handhole cover removed to allow free circulation of the air in the gas space.

For complete information on determination of dryness and additional methods of drying out, order I.L. 48-620-1 through the nearest Westinghouse Sales Office.

Vacuum Filling of Transformer

In order to obtain the vacuum levels specified and to maintain these levels during liquid filling, a good vacuum pump of adequate capacity will be needed. A 100 CFM pump will be adequate. The pump should be capable of obtaining a blank-off pressure of .02 TORR or less for 15 psi or full vacuum tank.

The transformer instruction nameplate gives the design tank pressure. Using this pressure and Table 3, the re-

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quired vacuum and holding time can be determined. The vacuum should be measured above the liquid level location.

Before filling, a sample of the liquid should be tested for dielectric strength. See "Sampling of Insulating Liquid" section of this booklet.

It is recommended that the liquid temperature be 10°C or higher during vacuum filling. The temperature of the core and coil must be above 0°C.

The liquid should be pumped into the tank through a filter press.

Table 3 – Vacuum Treatment and Liquid Filling

Condition	Absolute Pressure In Tank TORR	Vacuum Holding Time Hours
	15 P.S.I. or Full Vacuum Tanks	
Before Filling	5 Maximum	4
During Filling	6 Maximum	-
After Filling	*5 Maximum*	2
	8 P.S.I. Tanks	
Before Filling	347 Minimum	4
During Filling	347 Minimum	-
After Filling	347 Minimum	2

NOTE: 1 TORR = 1 mm Hg = .0193 P.S.I.

CAUTION: Where "MINIMUM" is specified lower pressures may result in tank damage or permanent deformation with serious damage to internal parts.

Gaskets

All gaskets used on Network Transformers are normally made of Cortite, a gasket material consisting of cork and synthetic rubber; and for satisfactory results replacement gaskets should be of the same material. Before replacing a gasket, carefully and thoroughly clean the steel surfaces between which the gaskets are compressed to remove rust, oil, grease, paint and other foreign material. The cleaning may be done by scraping or wire-brushing and then wiping the gasket surface with de-natured alcohol. Use gasket cement 53351GH when applying gaskets. Put the gasket in place and bolt the two surfaces together under uniform pressure. After the unit has been in service for a period of six months, retighten all the bolts.

Finish

Instructions for refinishing transformer are as follows:

1. If the paint on the unit is generally firm and sound, it is not advisable to strip the entire surface.

2. All rusted areas should be thoroughly wire-brushed, sanded, etc., to remove all rust, loose paint, etc.

3. Thoroughly wipe down with solvent-soaked rags to remove all dirt, oil, abrading dust, etc. Sometimes it is advisable to give the unit a light blasting using sand, ground corn cob or grounded walnut shell to roughen up the surface.

4. Apply by brush method a coat of fast-dry primer 3223ODU to all areas abraded to base metal; then follow with a complete spray coat of the fast-dry primer.

5. Allow to air dry overnight or apply moderate heat of 65° to 75°C for several hours.

6. After the primer coat is thoroughly dried, then apply a heavy, uniform spray coat of air dry black enamel 32211JR.

7. Allow to air dry for at least 24 hours before placing back in service. Moderate heat of 65° to 75°C for several hours is preferable if available.

8. Should extra protection be desired, then a second coat of the black enamel can be applied.

Additional Maintenance Instructions

The following are additional instructions that may be useful in maintaining the Network Transformer. These leaflets may be obtained by contacting the nearest Westinghouse Sales Office.

Removing and Replacing Welded-On Covers . . . . . I.L. 47-600-21
Instructions for Repairing Tank Leaks . . . I.L. 48-069-20
Cleaning Transformer Insulation . . . . . I.L. 48-069-13

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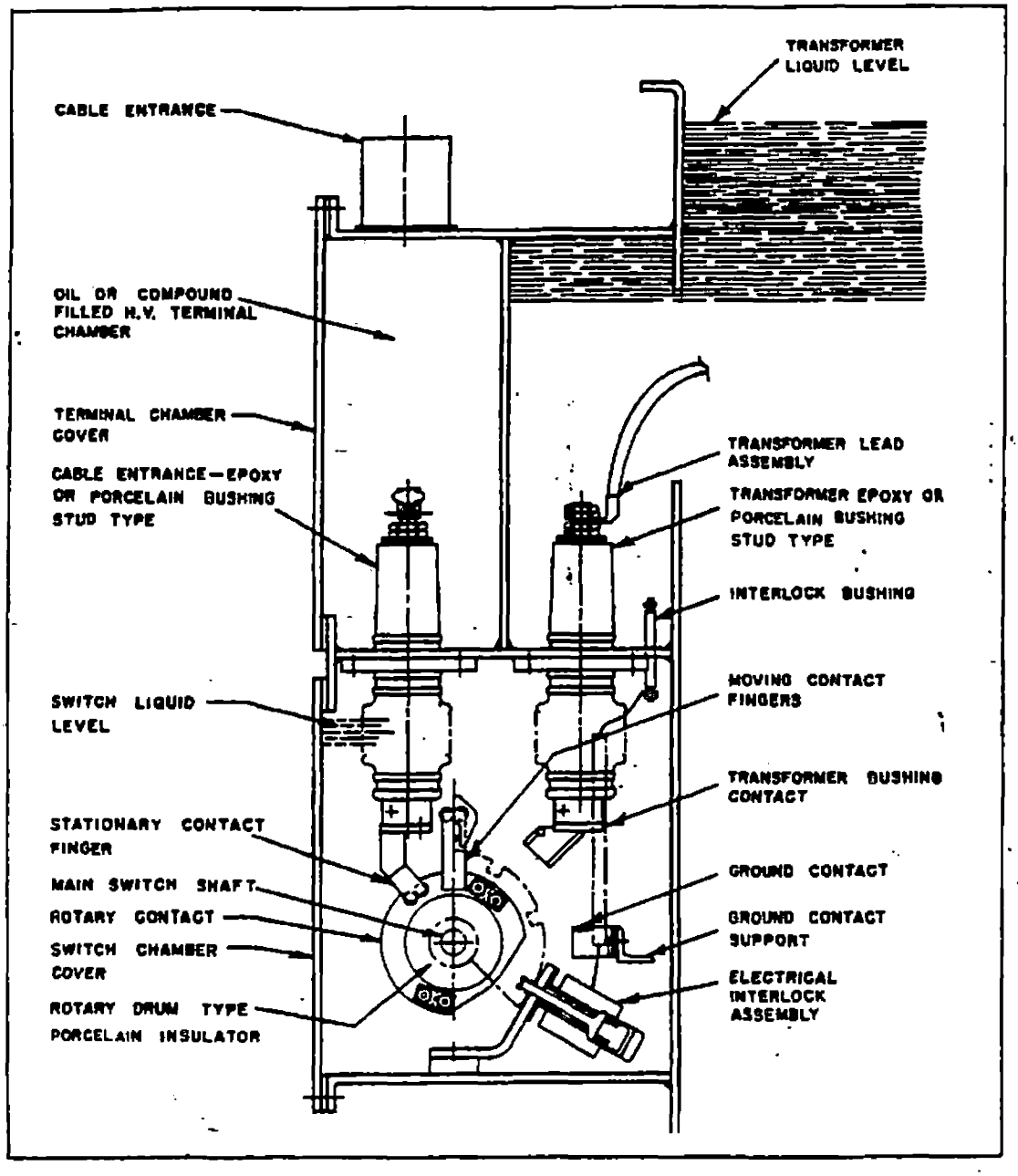


Fig 3 *High Voltage Disconnect and Grounding Switch*

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SECTION II NETWORK SWITCH

INTRODUCTION

The Network disconnect and grounding switch, see Figure 3, is normally welded to one end of the transformer tank. The switch is divided into two parts - a switch chamber and a terminal chamber. In the ground position, the switch will withstand a short circuit current of 15,000 amperes for five seconds without any appreciable movement of the contacts.

Description

The three-position switch is designed to have the following sequence: "open", "transformer", "ground", while the two-position sequence is "open" and "transformer." The operating mechanism compels a pause in the "transformer" position to allow the electrical interlock to "pick up" or lock the switch in the "transformer" position in case the feeder is energized.

The operating mechanism on both two and three-position switches includes a latching device which holds the switch in any normal operating position unless released by the operator and also provides a means by which the customer may padlock the handle.

The Network switches can be designed to interrupt the transformer exciting current (known as Mag-Break switch) or designed for de-energized operation (known as a Dead-break switch). The following interlock schematics show the types of operation. Figure 4 shows operation of the three-position Mag-Break switch.

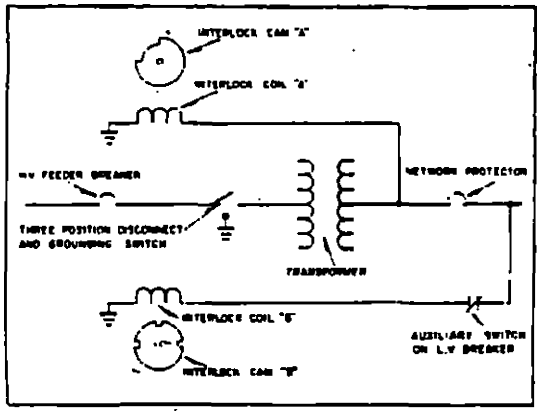


Fig. 4 *Three Position Switch Mag-Break Interlock Schematic*

The three-position, Mag-Break switch has two interlocks. Interlock "A" prevents movement from "closed" to "ground" position while the transformer is energized; Interlock "B" prevents movement from "closed" to "open" position while the LV breaker or network protector is closed.

Interlock "A" is connected directly to the transformer low voltage so that the interlock is engaged whenever the transformer is energized. Its associated cam is slotted so that the interlock does not interfere with movement from "closed" to "open" position but prevents movement from "closed" to "ground" position if the interlock is energized.

Interlock "B" is connected through an auxiliary switch on the Network Protector to the low voltage grid or separate power supply. When the protector is closed, this auxiliary switch is open and interlock coil de-energized. This interlock is arranged to lock when de-energized. Therefore, as long as the protector is closed the switch cannot be operated.

This interlock system requires a source of power independent of the associated transformer and at auxiliary contact on the protector. The schematic diagram shows one lead grounded and the other connected to the low voltage source for each interlock. In some cases both leads from each interlock are carried through and connected to the source.

The two-position Mag-Break switch schematic shown in Figure 5 uses only one interlock.

The interlock prevents movement from "closed" to "open" position while the LV breaker or Network Protector is closed.

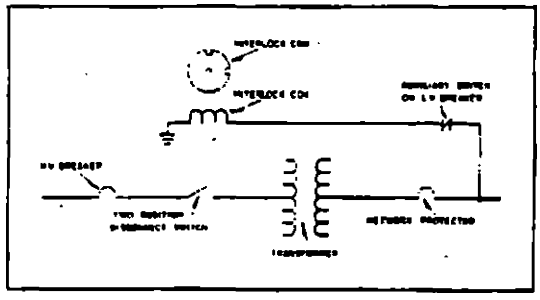


Fig. 5 *Two Position Switch Mag-Break Interlock Schematic*

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This interlock system requires a source of power independent of the associated transformer and an auxiliary contact on the Network Protector.

The interlock is connected through the auxiliary switch on the protector to the low voltage grid or separate power supply. When the protector is closed, this auxiliary switch is open and interlock coil de-energized. This interlock is arranged to lock when de-energized. Therefore, as long as the protector is closed the switch cannot be operated.

The Deadbreak switch interlock schematic is shown in Figure 6.

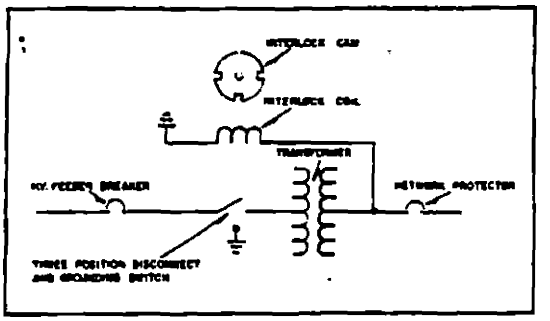


Fig. 6 *Dead-Break Interlock Schematic*

This interlock system uses one electrical interlock. The interlock prevents movement of the switch from "closed" to "open" and from "closed" to "ground", unless the transformer is de-energized. One side of the interlock is connected to the secondary side of the transformer and the other to ground. The interlock is engaged when the transformer is energized.

Voltage required for the interlock coils will be found on the instruction nameplate furnished with the transformer.

INSTALLATION

Before the transformer is installed, carefully examine the switch chamber for leaks. All switch chambers are tested at the factory. It is advisable to make a test at installation to make sure that no joints have opened during shipment. See "Pressure Test" in Section I.

Operate the switch a few times to make sure that all parts move freely. The switch chamber is shipped filled with liquid unless otherwise requested and the cover is sealed in place. It is not necessary to open the switch chamber since all cables are terminated in the terminal chamber.

Terminal Chamber

The terminal chamber cover gasket is cemented to the chamber side only. Cement is not used on the other side of this gasket to facilitate removal of the cover.

The terminal chamber is usually shipped dry and must be filled with insulating oil or compound after making cable connections and replacing cover.

Cable Connections

Cable connections are made in the terminal chamber. The cable entrance to the terminal chamber is normally through either:

1) Wiping sleeves

2) Packing glands (stuffing boxes)

3) Potheads or terminators

The type cable used is the key to the kind of connection required. The cable dictates the stress cone used, entrance required and the type compound needed to fill the terminal chamber.

Important: Refer to the cable manufacturer for stress relief cone requirements.

Insulating Compound or Oil

When specified on the purchase orders, either compound or oil can be supplied, otherwise the procurement is the user's responsibility. When compound is used, the selection of the proper compound for a particular installation depends upon:

1) Cable type and kind of insulation

2) Operating temperatures and voltages

3) Cable system elevation differentials (PILC cables only)

CHECK SPECIFICATIONS ON CABLE TO MAKE SURE THE COMPOUND TO BE USED IS COMPATIBLE.

The following instructions apply to preparation and pouring of compounds.

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1) Consult compound characteristics for pouring temperature. This is also shown on transformer nameplate if compound is supplied with transformer.

2) Always use a thermometer to assure proper pouring temperature. Voids may be formed if compound is not heated sufficiently. Compound that is heated too much may damage the insulation on the cable.

3) Warm the metal parts of the terminal chamber to drive off all moisture and wipe the bushings dry before replacing cover.

4) A filling plug is provided on top of the terminal chamber and a vent plug is located on the cover plate. Remove the filling plug and install a standpipe in its place. Remove the air vent plug.

5) Pour compound through the standpipe into the terminal chamber until it comes out the air vent hole.

6) Disconnect the standpipe and replace the filling and vent plugs.

SWITCH ACCESSORIES

Switches, when specified, may be equipped with auxiliary devices which aid in the installation of the transformer or provides additional safety.

Tap Changer Mechanical Key Interlock

This manually-operated interlock is designed to prevent operation of the tap changer unless the switch is in "open" or "ground" position.

Sequential Grounding Provisions

On the three-position disconnect and grounding switch, phasing-out contacts may be provided, if specified on the order, so that one phase of the cable can be grounded at a time. Buttons are provided on the operating handle for this operation. Sequence of grounding may be either left to right or right to left.

Phasing-Out High Voltage Cables

Move the switch handle from "transformer" toward "ground" with the latch pins on the switch control set for phasing out cable.

Caution: High voltage cable must be de-energized.

1. When pin marked A on the handle (See Fig. 7) stops the movement, the contacts are engaged for phase A. Phases B and C are open-circuited. Check for circuit through phase A with test voltage, then tag.

2. Release pin A on the handle and move the switch handle until pin marked AB stops movement. The contacts are then engaged for phases A and B. Phase C is open-circuited. Check for a circuit through phase B with test voltage, then tag.

3. With the switch in "ground" position, all three contacts are fully engaged.

Phasing Out Tubes

When specified on the order, phasing out tubes will be supplied to provide a means for phasing out the incoming feeder. The tubes are located on the switch cover and are angled such that when phasing probes are inserted through the tubes, the probes will come in contact with the live portion of the switch bushing. The phasing out tubes are sealed with either pipe plugs or pipe caps.

Special High Voltage Bushings

Occasionally, instead of the standard HV entrance, separable insulated connectors (Universal Bushing Wells) are supplied on top of the terminal compartment. In these cases the terminal chamber is filled with oil at the factory and need not be opened in the field. In making cable connections to these bushings, follow bushing manufacturer's recommendations for installation.

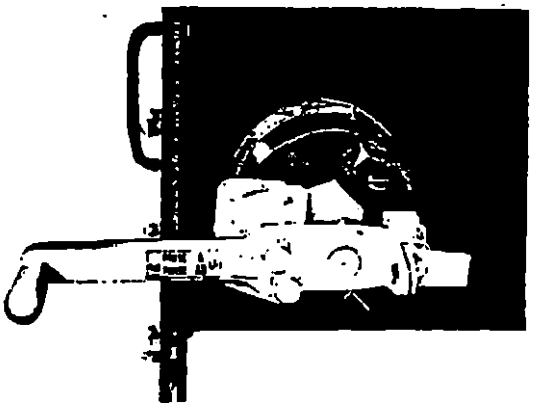


Fig. 7 *Network Switch Operating Handle*

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MAINTENANCE

Make a periodic examination to keep the switch in good condition and to insure trouble-free operation. Listed below is a recommended maintenance schedule for the Network switch.

Quick-Break Mechanism

The quick-break mechanism furnished on Mag-Break switches normally will not require maintenance. The mechanism uses an auxiliary contact arm which maintains the circuit as the switch is moved from "transformer" toward the "open" position. When sufficient clearance between main blade and its contact has been obtained, the auxiliary contact arm opens the circuit by quick-break action, regardless of the speed at which the operating handle is moved.

If a bushing of the quick-break arm is replaced, it should be adjusted so that all arms break or snap at the same time. This may be done by filing the end of the arm as much as is necessary.

Electrical Interlock

The electrical interlock is of the spring-loaded type. The moving latch is equipped with an adjustable tension spring to adjust the pick-up and drop-out voltages of the interlock. This assembly is adjusted at the factory according to the following table:

Interlock Adjustment

Interlock Coil Rating	Adjustment	
	Maximum Pick-Up Volts	Minimum Drop-Out Volts
125V-60 cycle	90V	15V
277V-60 cycle	200V	33V
460V-60 cycle	240V	45V
125V-D-C	65V	5V
250V-D-C	125V	5V

Do not disturb this adjustment unless the interlock is dismantled. The interlock is located in the main switch chamber, to the rear and below the rotary bushing. The

Switch Maintenance Schedule

	Oil Switch			Inerteen Switch			
	6 mo.	1 yr.	3 yr.	3 mo.	6 mo.	1 yr.	3 yr.
Main Contacts and Alignment			X(3)				
Auxiliary Contacts Alignment			X(3)				X(3)
Shaft Packing Gland	X				X		
Interlock Pickup Voltages & Operation		X				X	
External Mechanical Interlocks	X				X		
Switch Operation		X(4)				X(4)	
Quick-Break Latching Mechanism			X(3)				X(3)
Case Liquid Leaks	X			X(1)	X(1)	X	
Internal Liquid Leaks		X(2)	X			X(2)	X
Condition of Liquid (Color & Dielectric)		X		X(1)	X(1)	X	
Condition of Inerteen				X			

(1) After 3 months, then two 6-month periods and one-year intervals thereafter.
(2) Two 1-year intervals followed by 3-year periods.
(3) Or check after every 200 operations.
(4) Operate switch at least once per year.

In addition to the above, all cover bolts should be tightened and the pushbuttons on the operating mechanism should be oiled with a fine grade light machine oil.

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adjustment of the tension spring is varied by a screw attached to the spring and locked with two brass nuts.

Bushing Replacement

To replace a bushing, remove nuts from mounting studs or remove mounting bolts and pull bushing directly down to break gasket seal. Carefully remove any gasket material remaining on mounting surface. *When installing a porcelain bushing*, tighten all the bolts or nuts until the flange is .050 ± .010 from the surface on all sides. *When installing an epoxy bushing*, tighten bolts or nuts until the flange is .10 ± .01 from the surface on all sides.

Important: Replace bushing gasket before installing new bushing. Be sure to use a lock washer and cup washer on each bolt head or nut to insure locking.

After the bushings are in place, close up the chamber, using a new cover gasket and pressure test at 7 psig.

Gaskets

Refer to Section I "Gaskets."

Liquid Dielectric Tests

The dielectric strength of the switch liquid should be checked on a regular basis same as the transformer. See the transformer section of this book for further instructions.

Cable Insulation Test

The cable insulation can periodically be tested when connected to the switch bushing. Place the switch in the "open" position and test as follows:

Switch Rating	D-C Test Voltage	Time
15 KV	45,000	5 min.
25 KV	65,000	5 min.
35 KV	85,000	5 min.

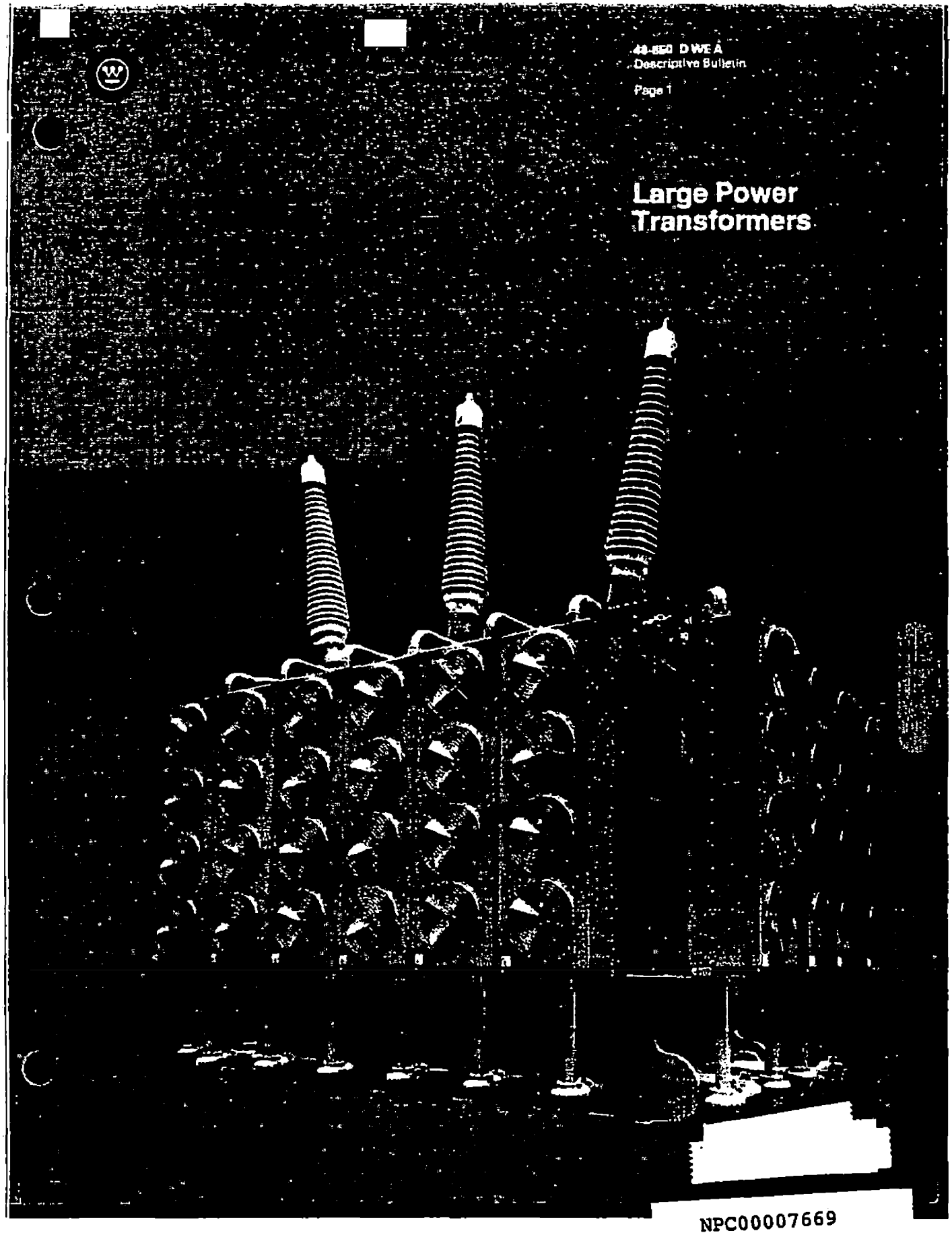
SECTION III RENEWAL PARTS

Renewal parts and renewal parts list may be ordered through the nearest Westinghouse Sales Office. When ordering parts or requesting service, give complete description of the part or problem and the serial number of the transformer as listed on the nameplate.

In order to expedite maintenance, the parts listed on the Recommended Renewal Parts List should be stocked by the user.

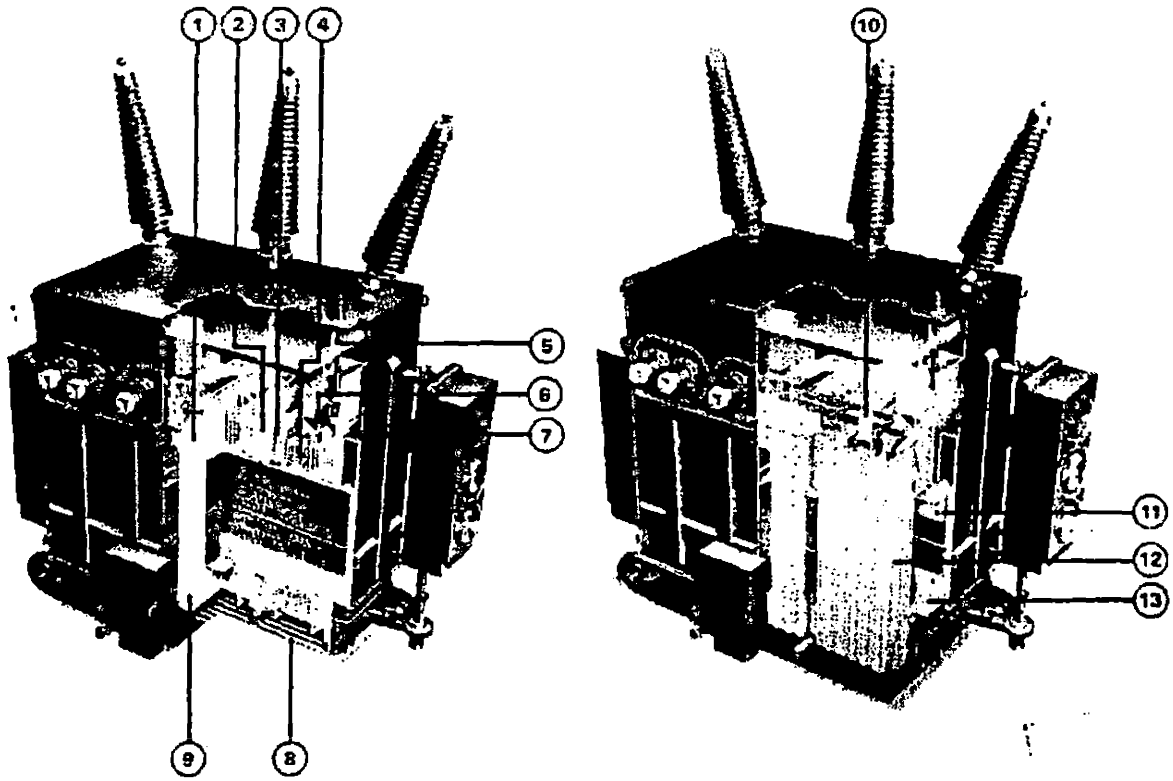
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Large Power Transformers



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Large Power Transformers – Cutaway Views



Westinghouse power transformers are used for transfer of electrical energy from generator to transmission system, at system interties and in large bulk power substations. Reliability is the foremost consideration in these applications.

Reliability is achieved in Westinghouse shell form power transformers without compromising economy of operation, physical size or initial cost.

General Description
A transformer design encompasses several interrelated components: An electrical circuit (coils) with proper proportions to give the necessary voltage transformation, a magnetic circuit (core) to provide magnetic coupling for the electrical circuit, an insulation system which also supports the electrical circuit, a high dielectric strength liquid (transformer oil) which also serves as a cooling medium, heat exchangers to dissipate the losses generated in the electrical and magnetic circuits, terminals for connection to an external energy system and a steel tank to mechanically support all components and contain insulating liquid.

Westinghouse transformer design satisfies the three basic criteria to assure reliable and economical service:

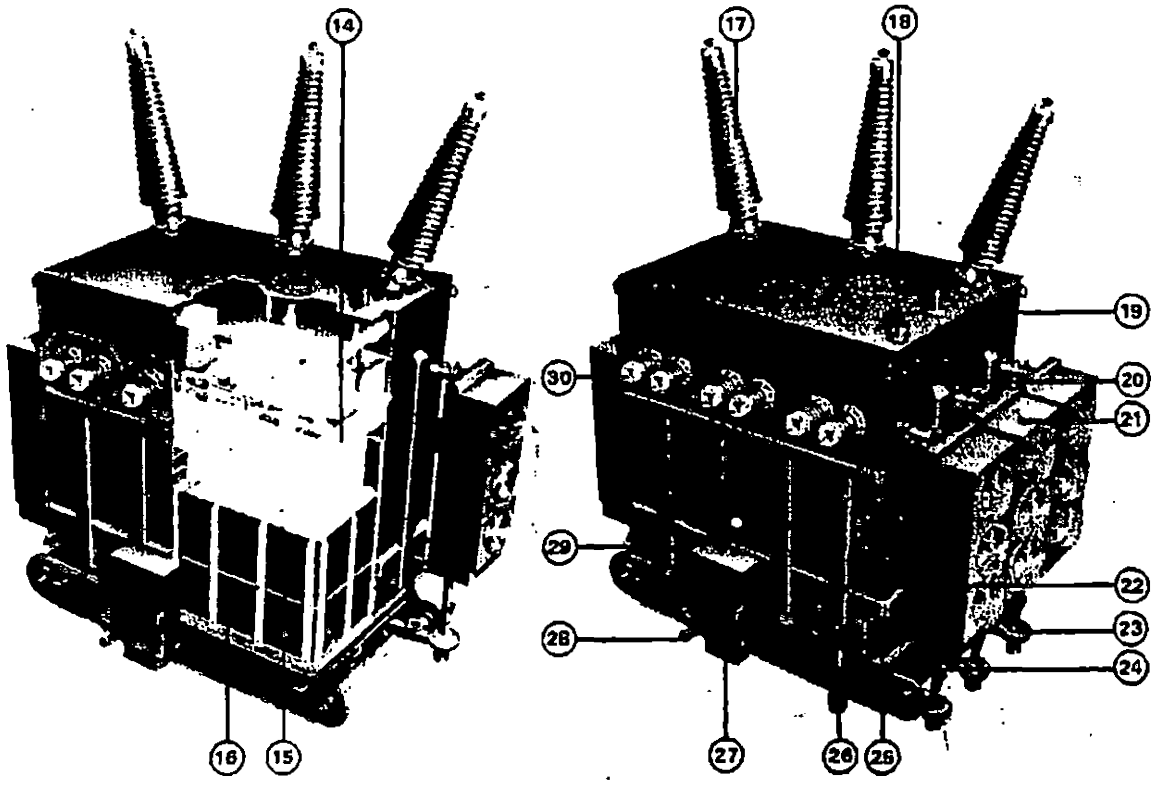
1. **Mechanical Strength** – The forces on the electrical and magnetic circuits due to handling, shipment and operation are supported by the insulation system and the steel tank.

2. **Thermal Capability** – Temperature is the most important factor affecting the useful life of a transformer insulation system. Hottest spot temperatures are lower in shell form transformers because direct cooling of the conductors is accomplished by oil flow over both sides of each coil.

3. **Dielectric Design** – The insulation structures are designed to eliminate excessive voltage stress, prevent ionization at test and operating voltages and eliminate corona discharges.

Further Information
Prices – Price List 48-820
Technical Data – Technical Data 48-660

1. **Pancake Coil**
2. **Inter-Phase Blocking**
3. **L.V. Coil Group**
4. **H.V. Coil Group**
5. **Hv Bushing**
6. **H.V. De-energized Tap Changer**
7. **Inner Tank Brace**
8. **Tank Shielding**
9. **Insulating Washer**



10 L.V. Bus Connection
11 Upper Core and Coil Support
12 Phase Wall
13 Lower Core and Coil Support
14 Bridge Wall
15 Core
16 Maple Core Block
17 H.V. Bushing
18 Pressure Relief Device
19 Transformer Tank Top Section
20 Liquid Level Indicator
21 Forced Oil, Forced Air Cooler
22 Temperature Indicator
23 Oil Circulating Pump
24 Transformer Tank Bottom Section
25 Interalrs System
26 Nitrogen Bottle
27 Control Cabinet
28 Drain Valve
29 De-energized Tap Changer Operating Mechanism
30 L.V. Bushing

Mechanical Strength

Significant benefits and advantages of the mechanical strength of Westinghouse Shell Form-Form Fit Transformer design:

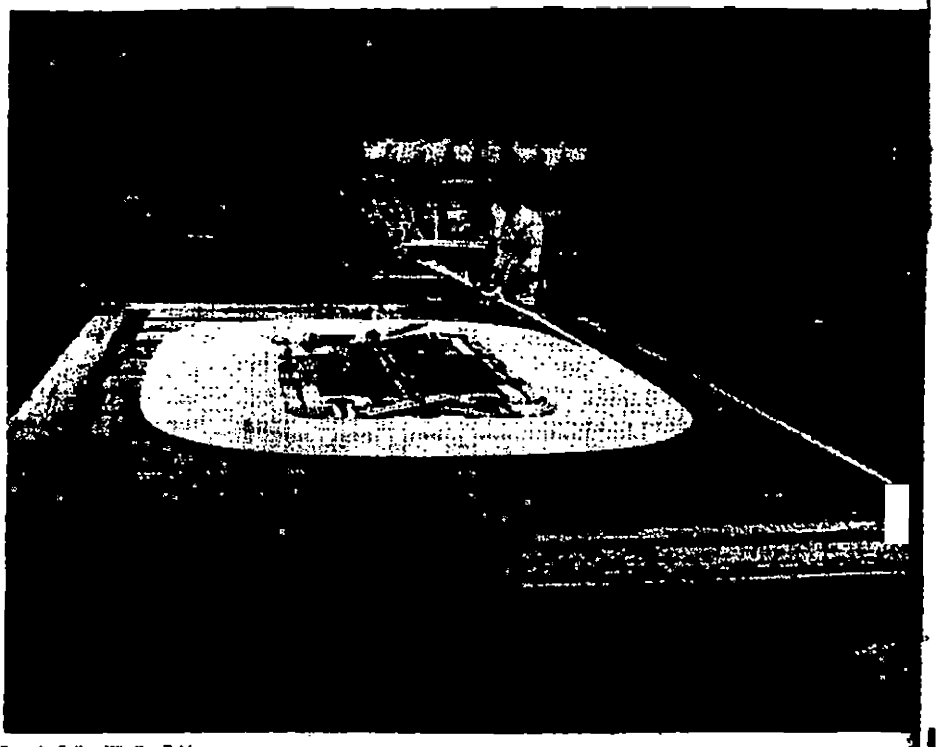
- As much as 40% less oil volume.
- As much as 10% reduction in total installation cost because of reduced oil volume and correspondingly less field oil processing.
- 30-40% greater mechanical strength.
- Westinghouse Shell Form Transformers incorporate over 80 years of experience in areas of design, fabrication and knowledge of material processing and testing to withstand the severe mechanical stresses imposed by Power System service.
- Westinghouse has successfully applied the mechanical principals of shell form, form fit designs to large power transformers rated 1300000 KVA three phase and 1000000 KVA single phase.

The problems associated with transformer mechanical strength and short circuit capability have been receiving increased attention from both manufacturers and users. This attention is well justified by the critical impact of possible transformer thru-fault failures on system operation. System conditions have been changing in a direction which has increased the exposure to, and magnitude of, system faults. Increased system capabilities, system interties and reduced effective transformer impedances all tend to increase the magnitude of thru-fault currents and the resulting mechanical stress on the transformer coil system.

Three specific design criteria; magnitude of forces, magnitude of stress and mechanical strength all contribute to the inherent mechanical capability of the shell form, form fit design.

Shell Form-Form Fit Construction

The coils in the shell form design are large surface area pancake coils. Both the HV and LV coils are assembled into winding groups with their faces adjacent to flat pressboard washers containing a planned pattern of spacer blocks cemented to the surfaces giving a relatively uniform support system for the turns and strands of the coils. The complete phase is installed vertically in the tank bottom and the core iron stacked around it. The upper section of the tank is fitted snugly over the core by shimming under the vertical wooden slats around the external periphery of the core.

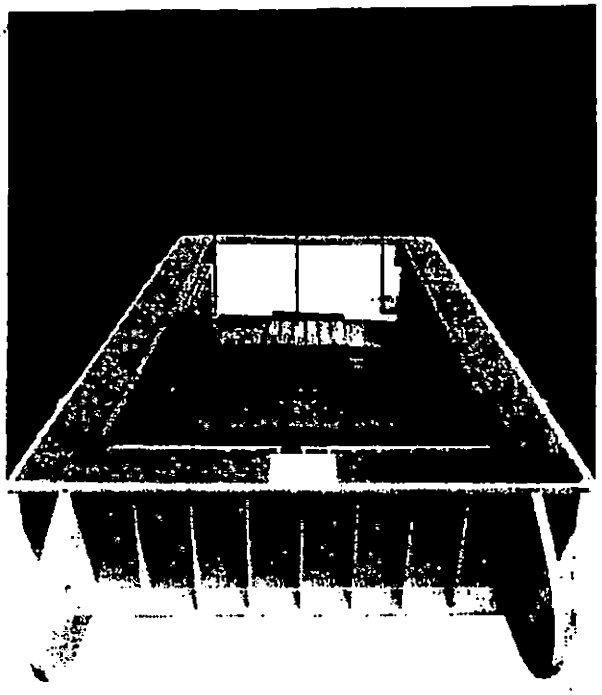


Pancake Coil on Winding Table

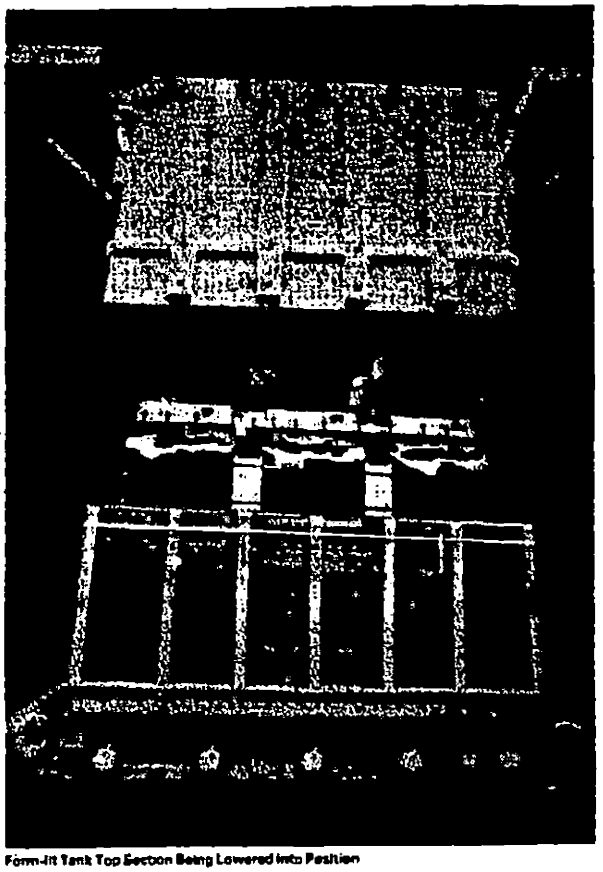


Partially Completed Phase Assembly

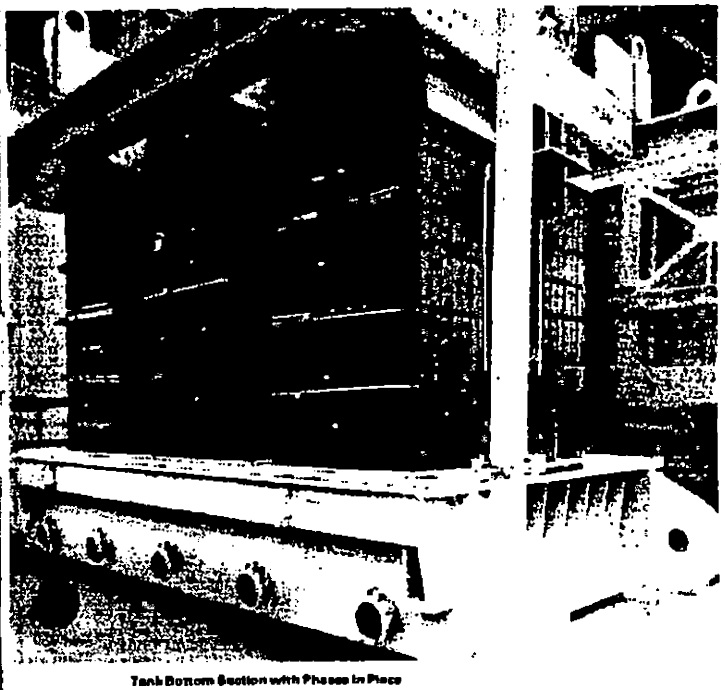
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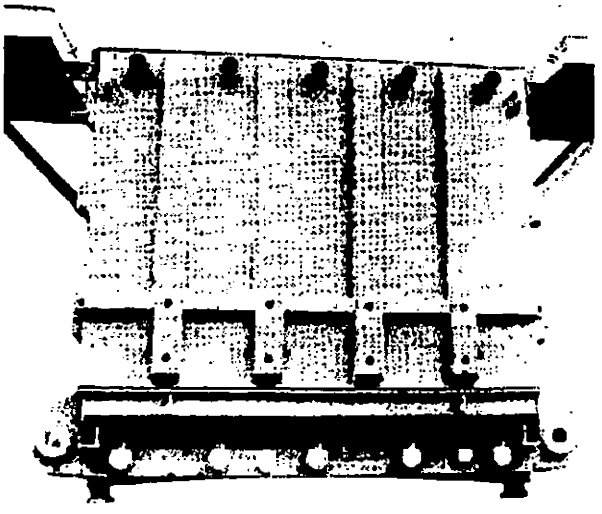
Tank Bottom Section



Form-fit Tank Top Section Being Lowered into Position



Tank Bottom Section with Phases in Place



Tank Top in Final Position

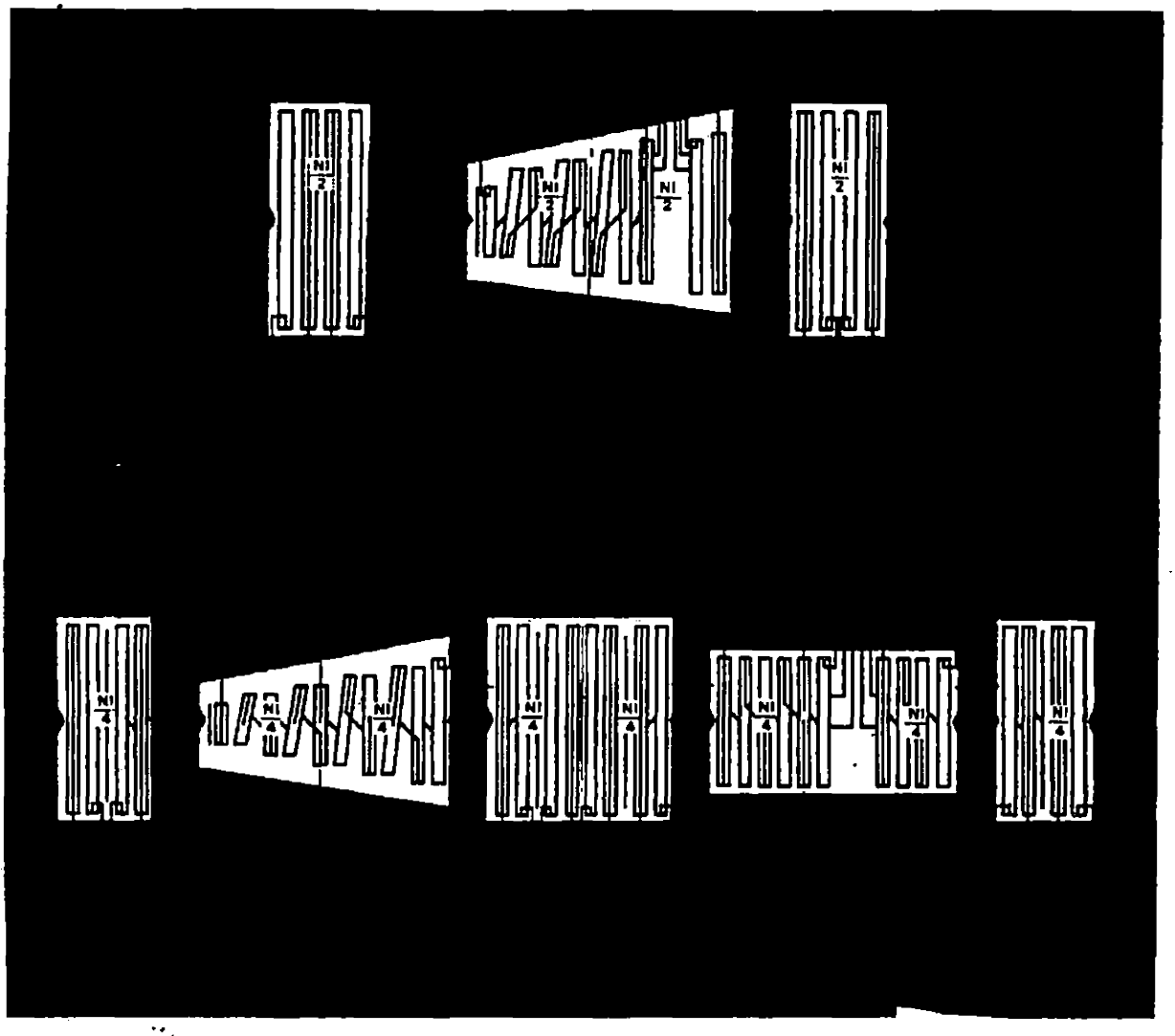
Magnitude of Forces

The total force between transformer winding groups varies as the square of the ampere turns per group. Thus if the short circuit current is ten times the normal load current the short circuit force will be $(10)^2$ or one hundred times the normal load winding forces. This would indicate, as transformers get larger it is *desirable to reduce the ampere turns per* winding group to control the magnitude of total force. This can be accomplished by increasing the number of winding groups, commonly referred to *an increasing the* number of high-low spaces. Increasing the number of high-low spaces does not increase the average mean turn length of the windings, and can be done economically in Shell Form Transformers. To clarify this somewhat, consider the change in going from a two high-low to a four high-low arrangement with no other changes.

It is well to note that while each group in the *two high-low arrangement, Figure 1, experi*ences a total force F, the successive group forces, as we traverse the windings, are in opposite directions and tend to cancel each other. As a result the net total restraining force F^1R which must be applied external to the windings is only the force corresponding to a single pair of winding groups.

If we kept everything else the same but subdivided the ampere turns from 2 to 4 groups in each winding we would obtain the force relationships indicated in Figure 2. The force on each group is now one fourth its previous value since the force varies as the ampere-turns squared.

Multiple high-low designs are used on Westinghouse Shell Form Transformers to achieve a reduction of forces between windings as MVA ratings are increased. This limits the total force magnitude on the individual coils.



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Magnitude of the Stresses

In addition to the control of total force magnitude available in shell form, form fit transformers, there is additional capability for keeping the unit stresses to lower levels. In transformers the forces throughout the windings and between the windings and the core or tank structures must be taken by cellulosic materials in compression. If these stresses become excessive the cellulosic materials will be crushed and the winding deformed and loosened under thru-fault conditions.

The major winding force component is perpendicular to the face of the pancake coils. Each coil is uniformly supported by spacer blocks on its adjacent pressboard washers. Between spacers the winding turns act as uniformly loaded beams as indicated in Figure 3. The total winding force is transmitted through the group by the compression of the spacer blocks. Since the shell form design uses large area pancake coils a large number of spacer blocks are available to take the total force resulting in relatively low unit stresses in the pressboard both within the winding groups and external to the winding.

Mechanical Strength

The total force magnitude is reduced considerably in the shell form design by use of multiple high-low winding arrangements. Even with this advantage it is still essential to have a rugged mechanical structure to withstand the ultimate forces encountered. In the shell form design the major components of force are taken by well braced structures completely outside the winding assembly itself.

A portion of the core of a shell form transformer is located inside the window opening of the coil and provides support for the coils in this area. The remainder of the core is stacked around the periphery of the coils forming a protective shell. The core in the window opening is supported by a structural T beam resting on the tank bottom section. The portion of the core around the periphery of the coils is supported by a well braced structural part of the tank bottom. The weight of the coils is carried by the upper structural T beam, the core and braces in the tank bottom section.

The close fitting form-fit tank and core assembly both combine to restrain the forces on the winding portions within the iron opening. Above and below the core large, heavy iron channels welded to the tank provide the restraint for the remaining portions of the windings. Since the bracing structures are completely outside the winding it is possible to reinforce them without the need for any compromises in winding design.

The Westinghouse Shell Form-Form Fit design offers a combination of controlled maximum stress and high mechanical strength to withstand the forces produced during through fault conditions.



Top Inter Phase Blocking



Bottom Inter Phase Blocking

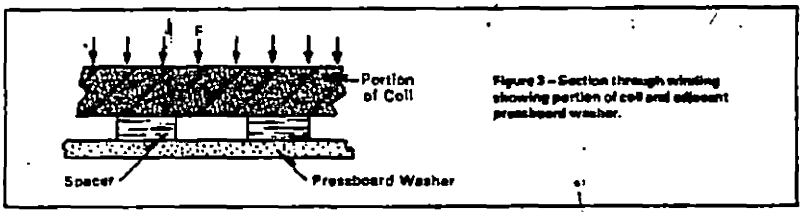
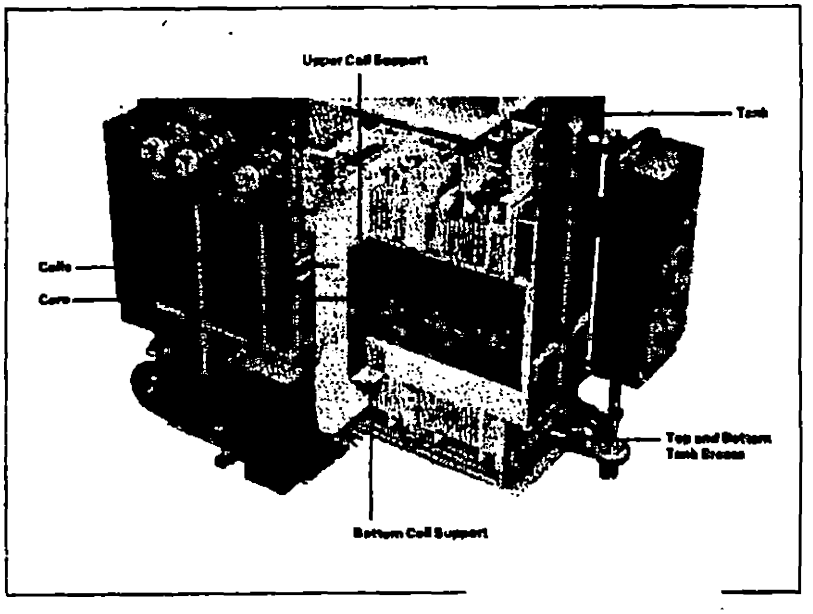
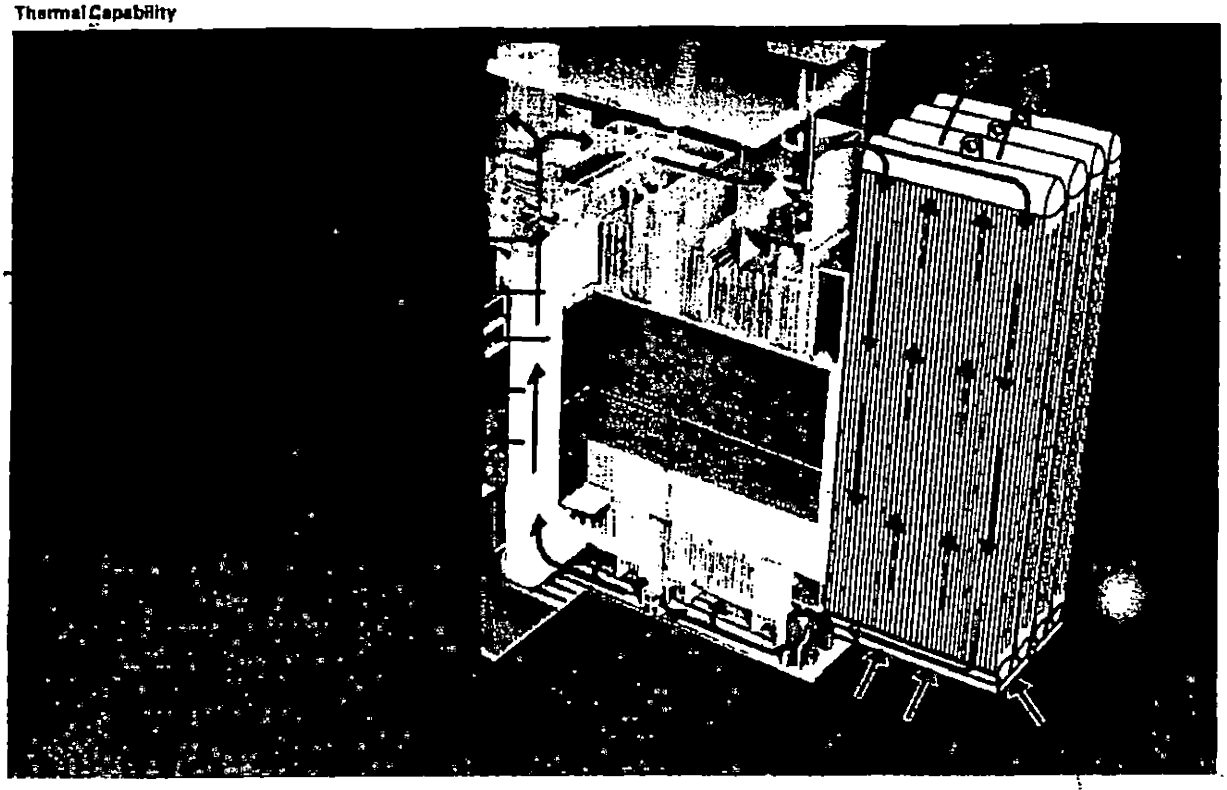


Figure 3 – Section through winding showing portion of coil and adjacent pressboard washer.



Thermal Capability



Significant benefits and advantages of the thermal capability of Westinghouse Shell Form transformers.

- Maximum cooling efficiency because of oil flow directly over both sides of the conductor.
- 5°-10°C lower hottest spot temperatures during both self-cooled and forced-cooled operation.
- 3-5% lower I^2R loss during forced-cooled operation because of reduced conductor temperatures.
- As much as 5% increased insulation life because of reduced conductor temperatures.
- Up to 10% greater thermal capacity both for continuous loading and for short term overload capability.
- Insuldur thermally stabilized insulation system providing continuous 12% additional load capacity.(1)

(1) Ask for SA 9025 for a complete description of the Insuldur system

A transformer is a very efficient device, however, the losses in the electrical circuit and the magnetic circuit generate heat which must be dissipated. The transformer oil, in addition to being a liquid insulator, serves as a means of carrying the heat away from the working parts of a transformer to a heat exchanger where it can be dissipated to the atmosphere. The efficiency of the dispersion system determines the thermal capability and insulation life of a transformer.

Superior thermal capability is inherent in Westinghouse shell form transformers during both self-cooled and forced-cooled operation.

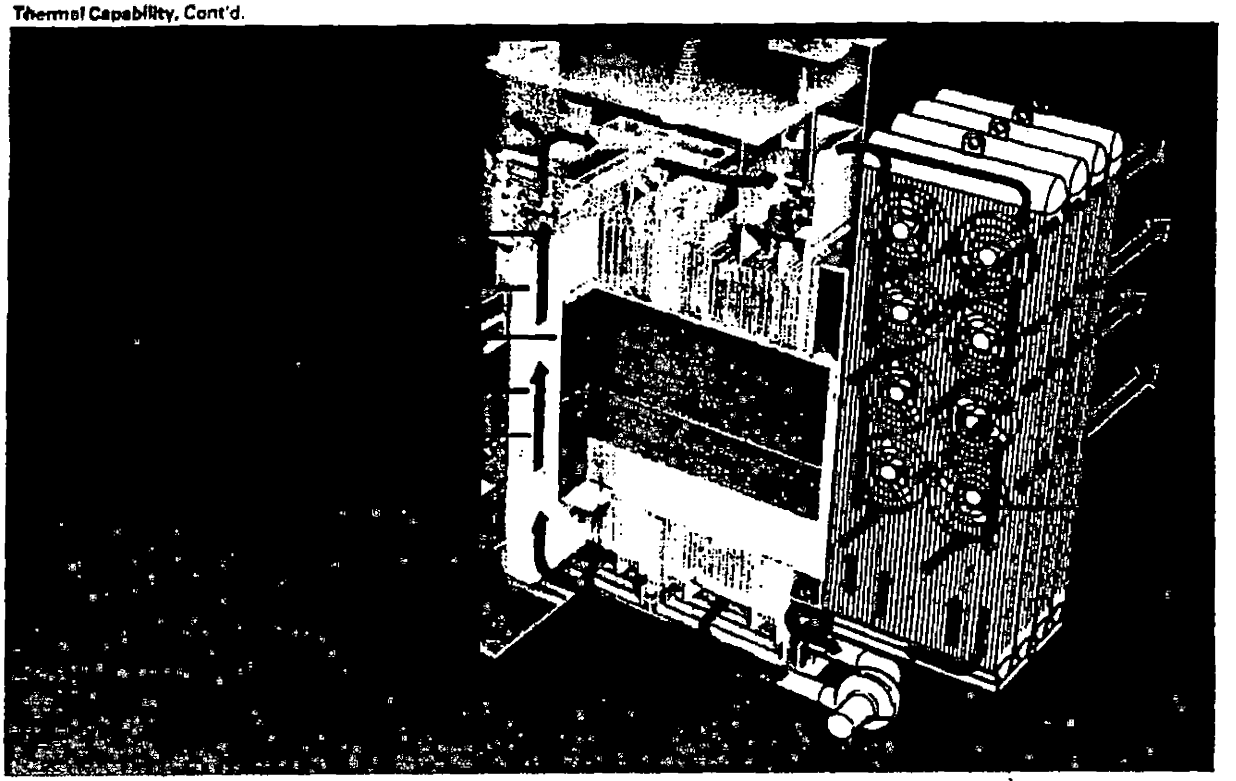
A thermosiphon cooling action functions in the transformer during OA (Self-Cooled) operation because of the temperature differential between oil at the top and bottom of the transformer tank. This temperature differential, thermal head, is approximately 12°C for an OA transformer, and will support an oil flow exceeding four feet per minute over the core and coil surfaces.

The pancake coils are mounted vertically and the pressboard insulating washers with a predesigned spacer block pattern are located on either side of the coil providing an ideal path for oil flow over both sides of the conductor surfaces. A large portion of the coil surface in a shell form transformer is positioned in the cool oil near the bottom of the tank where direct heat transfer is most efficient. The core construction is a relatively high stack of narrow width silicon steel punchings, thus oil flowing on either side of the core adequately cools this area and oil ducts within the magnetic circuit are not necessary.

The cool oil rises from the bottom of the tank, traveling over the conductor surfaces picking up heat as it moves to the top of the tank and then out through the heat exchanger, where it cools. The cooled oil re-enters the transformer tank at the bottom.

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Thermal Capability, Cont'd.



The typical temperature rises are as illustrated. The average copper temperature rise is set by ANSI or NEMA Standards, and for this example is 55°C. The top oil rise is 48°C, the bottom oil rise, 36°C – a difference of 12°C which is the thermal head required for oil circulation. The average oil rise is 42°C.

All temperatures at this operating condition will stabilize if the load remains constant and the difference between average copper rise and average top copper rise will be 6°C, or the same as the difference between top oil rise and average oil rise. The average top copper temperature rise then is 55°C plus 6°C or 61°C.

Hot spots will occur in the coil due to oil flow restriction by the spacer blocks. At the OA rating this allowance is 2°C, this added to the average top copper temperature of 61°C results in a hottest spot temperature of 63°C. ANSI Standards allow a 65°C hottest spot temperature for a 55°C rise transformer.

Forced cooling is applied to transformers to increase their thermal capability without adding active material. Forced cooled units can be designed with a single rating using pumps and fans for forced oil and forced air (FOA) or forced oil with a water cooled heat exchanger (FOW). Triple rated units are commonly used in application with heavy cycling loads and the forced cooling is applied in two equal stages. Pumps as well as fans are again used providing OA/FOA/FOA ratings at 100%/133%/167% with the self-cooled rating considered as the 100% base.

The OA operating data illustrates the flow of oil caused by the thermal head in the transformer, however, it is obvious that the thermal head contributes to the total hottest spot temperature of the transformer. For this reason, Westinghouse shell form transformers employ pumps to circulate the oil during forced cooled operation. Since total temperatures are also proportionate to oil volume flow, the increased oil flow made possible by the pumps further reduces operating temperatures for any given load condition.

Typical temperature characteristics of a forced cooled transformer operated at its maximum rating are illustrated above. Again using an average copper rise of 55°C, the top oil temperature is 45°C and the bottom oil temperature is 43°C – a difference of only 2°C. We have almost eliminated the thermal head because oil circulation is forced by the pumps. The average oil temperature is 44°C and after the temperatures stabilize the average top copper temperature rise will be 56°C.

Hot spots will also occur during forced cooled cycles and will increase slightly due to increased losses and restriction of oil flow. The hot spot allowance is now 4°C giving us a hottest spot temperature rise of 60°C. Similar temperatures and operating characteristics can be obtained if the transformers are operated at 65°C average copper temperature rise.

Dielectric Capability

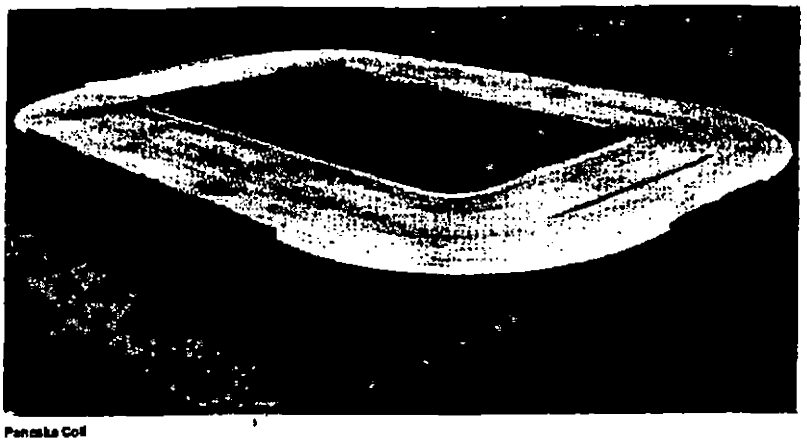
Significant benefits of the Dielectric Capability of Westinghouse Shell Form Power Transformers.

- The inherent high coil-to-coil and low coil-to-ground capacitance ratio provides uniform distribution of surge voltage over the entire coil system.
- Insulation structures are predesigned and strategically placed to utilize the oil impregnated pressboard insulation in puncture rather than creep for up to 300% additional strength.
- Tap and line end connections are made at the top of the coil with short predesigned leads thus minimizing the effect of localized heating due to high flux fields.
- The exclusive Westinghouse modeling technique and prototype testing verifies the transformer reliability before manufacture.
- The annual trouble rate for Westinghouse Shell Form Transformers is less than ¼ the rate of those manufactured by other companies.

Transformers designed for use in large substations, system interties and generator step-up applications, where reliability is of utmost importance, require careful consideration of transient surge overvoltages.

The effect of the various overvoltages and surge conditions on the windings of the transformer is determined by the characteristics of the particular coil and winding system. As these transients enter the transformer winding, the initial voltage distribution will be directly determined by the capacitance network of the coil and winding system. Oscillations may develop as the surge progresses through the coil system, which for certain designs may be amplified by the natural oscillation in these systems to a value greater than the initial crest. This overvoltage condition may concentrate at some point in the winding, such as the first several turns at the line end of the winding and stress the turn-to-turn insulation in these areas.

The coil assembly of a Westinghouse Shell Form Transformer consists of a relatively few "pancake" coils with a broad cross-sectional area and a narrow coil edge. Since the capacitances between coils and from coil-to-ground are directly proportional respectively to the cross-sectional area of the coil and the area of its edge, the Shell Form Coil System has a high coil-to-coil and a low coil-to-ground capacitance. When the ratio of the coil-to-coil capacitance to the coil-to-ground capacitance is high, as in the shell form transformer design, the voltage distribution across the coil group with rapidly rising transient voltage is more nearly uniform. The design of the shell form generator step-up transformer, employing multiple high-low winding groups connected in parallel further increases the coil-to-coil capacitance and the capacitance ratio in these units, thus magnifying this inherent design advantage.

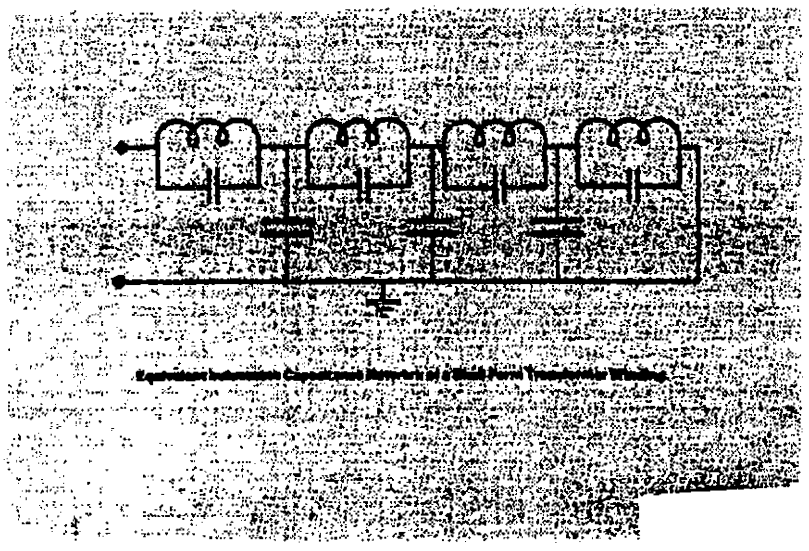


Pancake Coil

The turn-to-turn voltage stresses due to the initial application of the surge are thereby reduced in the shell form design insulation system, and the succeeding oscillations developed in the winding are also reduced. The large inherent capacitance of the shell form design causes the natural period of the winding oscillation to be relatively long thus allowing the surge voltages to decay to a low value before the winding oscillations can develop to a significant magnitude.

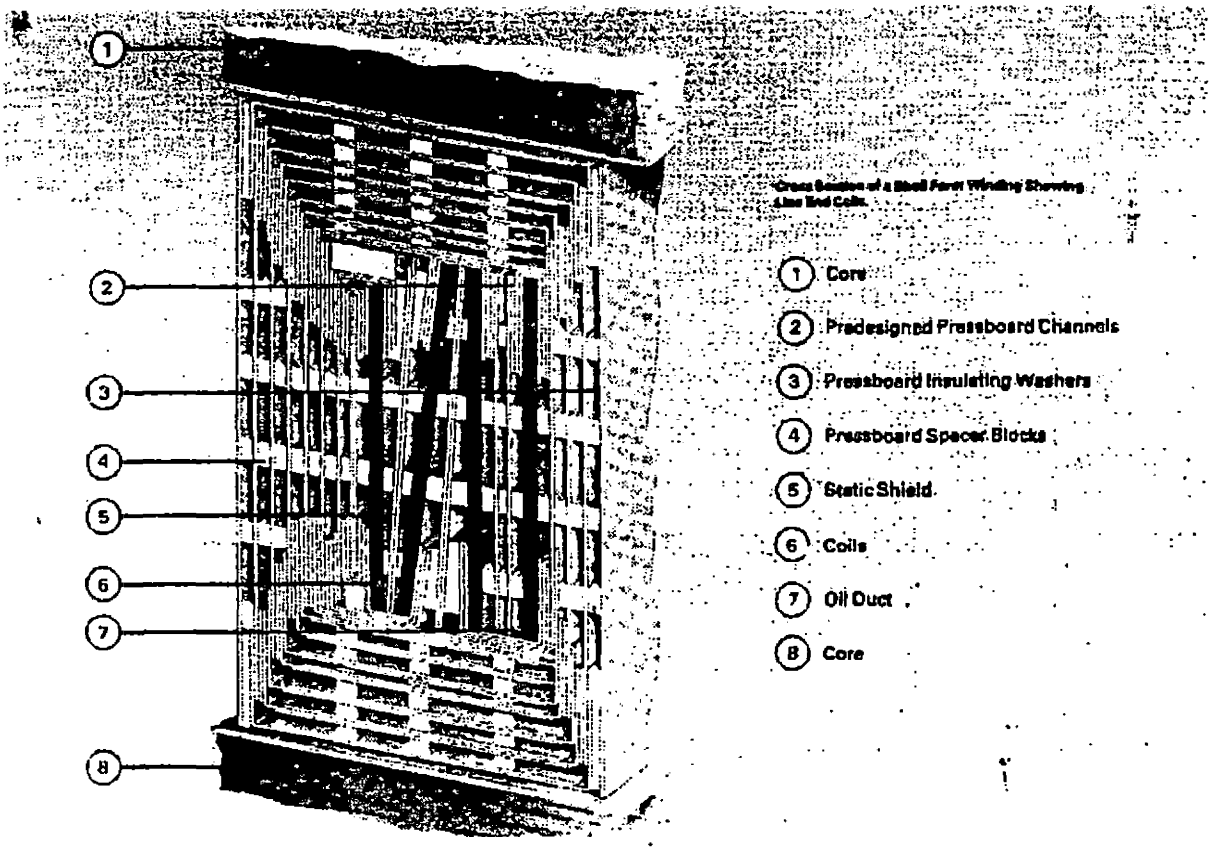
The insulation structures between coils, between coils and core, and between winding groups are made of high dielectric strength oil pregnated sheets. Oil spaces are provided with precise relationship to the pressboard structures to control voltage stress concentrations. Special formed insulation pieces are used over the coil edges where the voltage stresses are highest. This insulation is utilized in puncture rather than creep for maximum strength.

The pancake coils are arranged to terminate at the top of the transformer where connections can be made with a short lead. Mechanical bracing of leads can be readily done and, because of the short lead length, the magnitude of circulating currents induced by high fields is minimum.



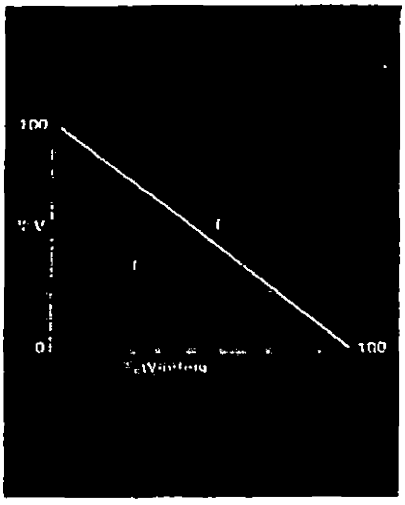
Equivalent Inductance-Capacitance Network of a Shell Form Transformer Winding

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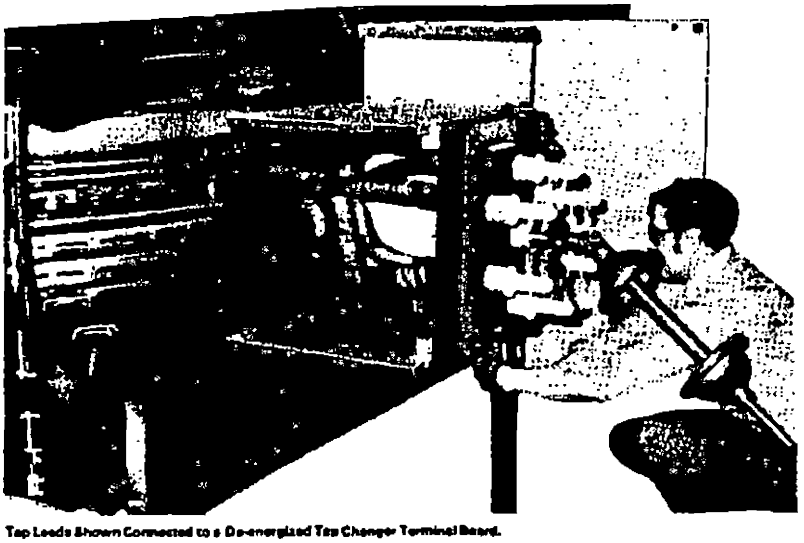


Cross Section of a Shell Form Winding Showing Line End Coils.

1. Core
2. Predesigned Pressboard Channels
3. Pressboard Insulating Washers
4. Pressboard Spacer Blocks
5. Static Shield
6. Coils
7. Oil Duct
8. Core



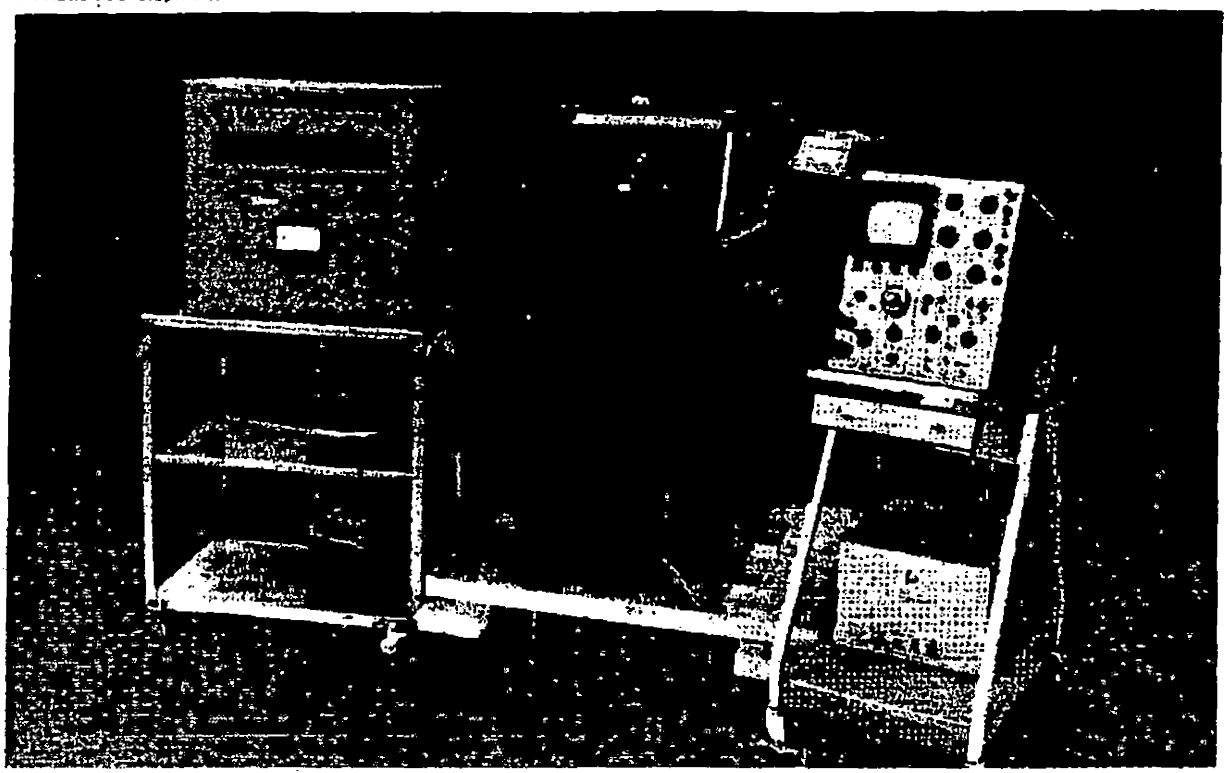
Initial Surge Voltage Distribution Curve in a Shell Form



Tap Leads Shown Connected to a De-energized Tap Changer Terminal Board.

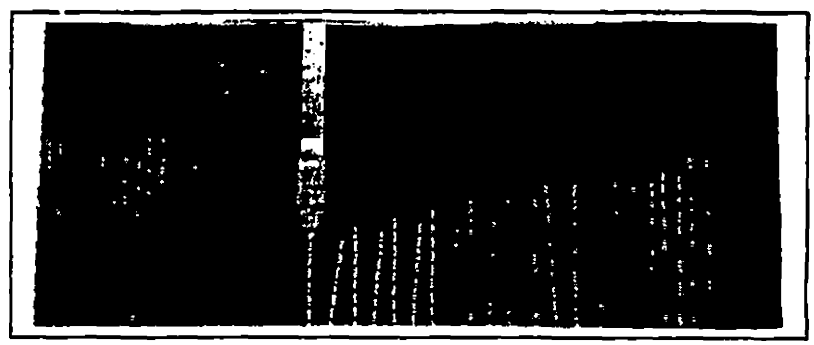
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Insulation Development



Historically, when higher voltage levels were required for transmission of power, equipment designs were extrapolated from existing data. This approach generally resulted in applying additional insulation to the transformer coil systems to meet prescribed electrical clearances. Westinghouse engineers determined that this approach was wholly inadequate, and, in many instances, the added insulation created new problems.

Knowledge in the science of electrical insulation development derives from basic component research on electrode creep charactoristics, insulation corona performance, and the mechanical and thermal capabilities of insulation structures. When the performance of a component measures successfully in these relatively isolated studies, the next step in the Westinghouse development program is to subject it to simulated use tests in a scale model transformer. These models are designed in ¼ Electromagnetic scale, providing complete access to the coils and turns of the unit: when switching surge or impulse signals are impressed from a signal generator the performance of the model (and resulting voltage variations) duplicate the performance of a full size transformer.



Resistance Analog Dielectric Field Plot Showing a Portion of a 765-345 KV Autotransformer Winding.

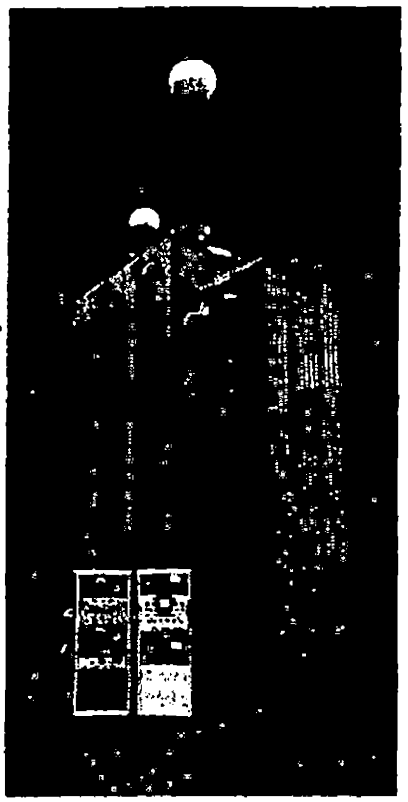
The voltages obtained from the model test are plotted on a resistance analog dielectric field plot, where a final study of the performance of the insulation structure is made from the resulting equipotential lines and indicated voltage stresses. These studies are made for voltage conditions such as steady state, impulse, switching surge, and low frequency.

If additional data is needed, a digital dielectric field plotting technique is used to amplify a minute section of the transformer to study its performance under varying voltage conditions.

When our engineers are satisfied that they have as complete information as can be derived from component study and modeling programs, and the information is favorable, the next step is to build a full size prototype transformer, incorporating the newly developed concepts.

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Prototype Testing

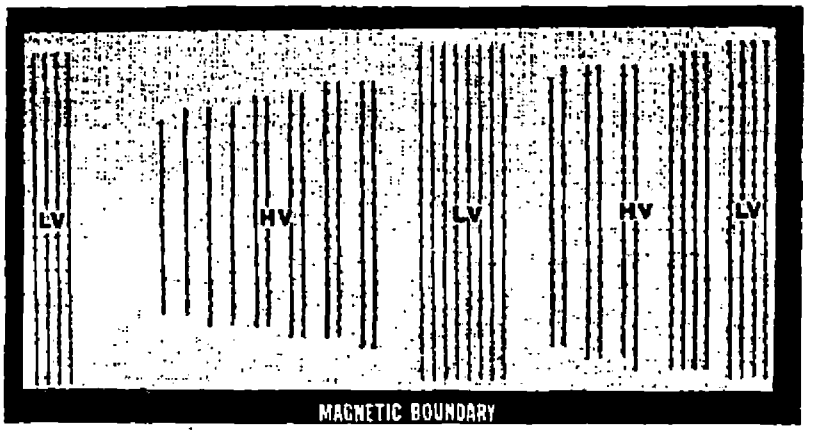


A Single Phase Prototype Transformer Undergoing Corona Tests

Westinghouse uses three prototype transformers to verify laboratory performance of components. The extent of the Westinghouse research and development programs may be indicated by the fact that each of three transformers will, on the average, be built twice a year – providing a total of six development units per year.

Normal procedure is to build a phase which has some nominal BIL such as 825 KV, then subjecting it to impulse, switching surge, and low frequency tests at voltage levels associated with ever increasing BILs, until the structure fails. The prototype transformers are operated well above nameplate voltage rating for long periods to make exhaustive tests of an insulation structure and to fully determine its performance in a full size transformer.

This effort has resulted in a virtual elimination of structural insulation test failures in transformers shipped from the Large Power Transformer Division.



Leakage Flux Field Plot of a Typical Shell Form Winding.

Magnetic Field Investigations

The dramatic growth in generator step-up transformer ratings has created another type of potential difficulty. For example, a comparison of the secondary current of a one million KVA transformer manufactured in 1970, with the secondary current of a one hundred thousand KVA transformer supplied in 1947, reveals a current ratio of 10 to 1 but more significantly, a leakage flux field heating effect ratio of 50 to 1.

The magnitude and geometry of the leakage flux field at any point in a transformer are a function of the ampere turns in all windings, the insulation spaces and the magnetic boundries of the core and tank walls. The determination of these fields in two dimensions presents an intricate problem. However, the fields are three dimensional in some regions, increasing the complexity of a precise solution. Westinghouse engineers are using digital computer programs derived from unique mathematical field analysis equations to determine the flux field at any point in the transformer subject to heating.

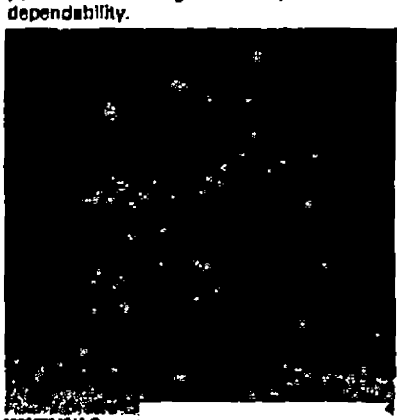
An equally important and difficult part of this problem is to determine the heating that can result in a given flux field. Very complex mathematical analyses are required for these problem solutions and the results must be confirmed by experimental testing. Westinghouse engineers, skilled in mathematics and field theory, have successfully developed components and design methods of preventing over heating. Extensive laboratory facilities are in use to continue this work on even larger transformers that will be required in the future.

Prototype transformers are used in the study of leakage flux heating and to verify design principles that have evolved from the mathematical and experimental studies. The validity of our field plotting methods has been confirmed by measuring the flux density in the experimental units at several thousand points, then comparing the measured values with the calculated values. Tests performed with very high overcurrents to exaggerate the heating effect, have successfully proven the new design principles.

Leakage field calculations of large production units are a part of the design procedure, thus eliminating potential heating areas prior to manufacturing the transformer, and assuring its reliable performance.

Transformer performance characteristics have been analyzed in conjunction with leakage field studies and several changes in conductor and coil configuration have resulted in improved efficiency levels.

Westinghouse engineering, research and design capabilities have effected a dramatic improvement in the service performance record of large power transformers, bringing current performance to a high state of operational dependability.



1290000 KVA Generat

Vapotherm Insulation Processing
The assembled transformer phase is clamped with heavy spring loaded beams, to assure dimensional stability during processing and to adjust for material shrinkage. The complete transformer phase assembly is placed in the processing vessel, the vessel is then sealed and evacuated to remove all oxygen and moisture. A hydrocarbon solvent is used to rapidly and uniformly transfer heat into the insulation and raise the temperature of the entire structure, thereby accelerating moisture removal from the Kraft insulation. Overheating and prepging of the exterior insulation parts does not occur because no oxygen is present and because of the uniform heat transfer by the solvent vapor.

The heating and moisture removal continues until the system pressure reaches the solvents liquid-vapor equilibrium curve. At this time the liquid solvent is removed.

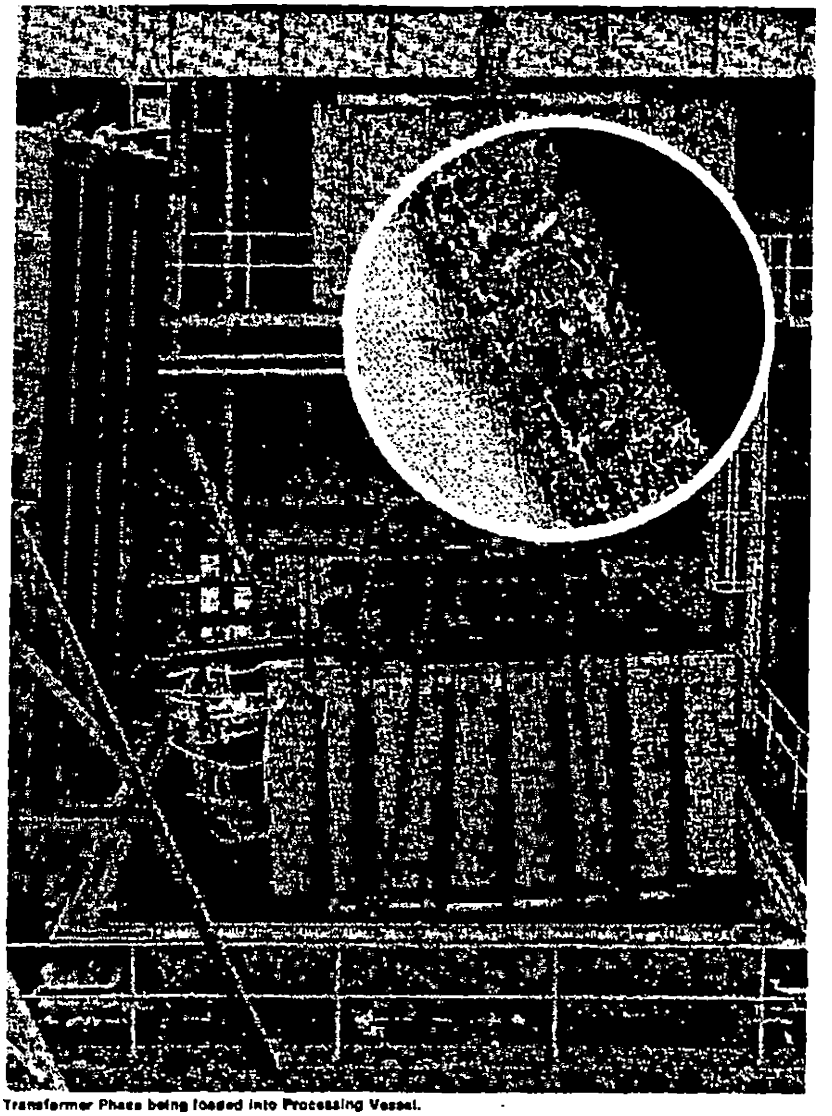
Evacuation continues until the last traces of solvent and moisture are removed from the system

The power factor of the insulation is monitored during the entire cycle and must be at a low level as a final check at the conclusion of the drying cycle.

Insulating oil is admitted into the processing tank without relieving the vacuum to completely impregnate the Kraft paper insulation and eliminate corona producing bubbles. The oil fills the voids in the Kraft paper, assuring high short circuit strength and a dry, dimensionally stable phase assembly throughout subsequent operations. The transformer phase is then removed from the processing tank.

After assembly is completed, the transformer is processed in its own tank with hot oil under a low vacuum to remove any surface moisture from the insulation that may have accumulated during assembly.

Final control of the process is achieved by checking the insulation power factor at the conclusion of the dry out cycle, to be certain it has remained at a low level.

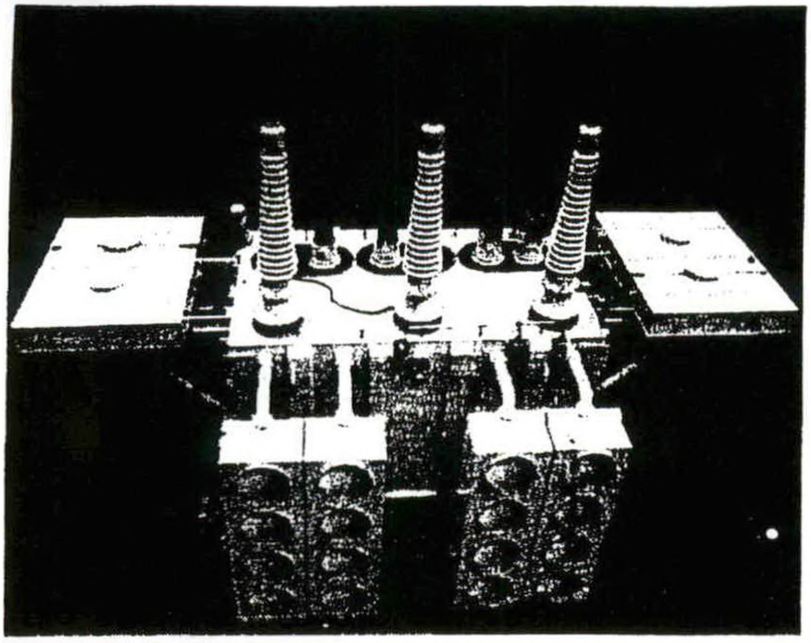


Transformer Phase being loaded into Processing Vessel.
(Insert) Expanded End View of Kraft Insulation

Summary of Benefits:

- Dryout and oil impregnation are accomplished in a single processing vessel.
- Spring loaded clamps adjust for material shrinkage and assure a tight insulation assembly.
- Solvent heat of vaporization raises the temperature of the insulation structures at a uniform rate. Prepging and embrittlement of insulation material is eliminated.
- Insulation structures are impregnated with dry oil to prevent subsequent moisture absorption and to assure maximum dielectric and mechanical strength.
- Closer dimensional control of insulation parts is possible allowing size and weight reduction of the completed transformer

Testing



Generator Step-up Transformer Undergoing Temperature Test.

Indisputable proof of the reliability of a transformer and confirmation of its performance characteristics are established by tests. All Westinghouse shell form transformers are tested in accordance with American National Standards Institute Test Code for Transformers.

Standard Tests applied to all units:

- Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on an order.
- Ratio tests on the rated voltage connection and on all tap voltages.
- Polarity and phase-relation tests on the rated voltage connection.
- No load loss at rated voltage connection.
- Exciting current at rated voltage on the rated voltage connection.
- Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating of an order.
- ANSI Temperature Test.
- Applied Potential Test.
- Induced Potential Tests.
- Westinghouse Quality Control Impulse Tests.
- Westinghouse Quality Control Corona Test on all units 345 KV and above.

Tests which will be performed at purchaser's option and at additional cost:

- ANSI Impulse Tests.
- NEMA Front-of-Wave Impulse Tests.
- Switching Surge Test.
- Audio Sound Level Measurement.
- Low Frequency Over Voltage Tests for EHV Transformers.

Impulse Testing
The most comprehensive demonstration of transformer insulation strength is the ability to withstand low frequency tests and impulse tests. Westinghouse uses a Quality Control Impulse Test to check the adequacy of design, materials and workmanship on all shell form transformers. These tests are made in addition to the low frequency test required by ANSI Standards.

The test consists of applying a reduced full wave, two chopped waves and one full wave in this order to each line terminal. The crest values of the impulses have a minus tolerance of 5% in addition to the ±5% tolerance allowed by ANSI Standards.

Westinghouse pioneered the impulse testing of transformers and began commercial use of the test in 1931.

This type of testing maintains the high degree of quality in Westinghouse shell form transformers.

Corona Testing
The Westinghouse procedure for corona testing EHV transformers requires a RIV measurement on the HV winding during the Induced Test. The measurement procedure and instruments as prescribed in "NEMA 107 – Methods of Measuring Radio Noise" are employed, except the power supply is connected to the lowest voltage winding of the transformer being tested and the bushing capacitance tap is used to connect the RI meter to the HV terminal.

The induced voltage is raised to approximately 50% full test value, a value above operating voltage, and the RIV is measured. The test voltage is then raised to the full test value and held for 7200 cycles. An RIV measurement is taken at this voltage. After the low frequency test is completed, the RIV is again measured at 50% full test voltage. If the RIV levels at 50% induced voltage level exceeds 100 microvolts or if the RIV level at full test voltage exceeds 500 microvolts, additional testing will be performed to demonstrate the reliability of the transformer.

Westinghouse performed the first commercial corona test in 1958 and began corona testing every EHV transformer in 1966.

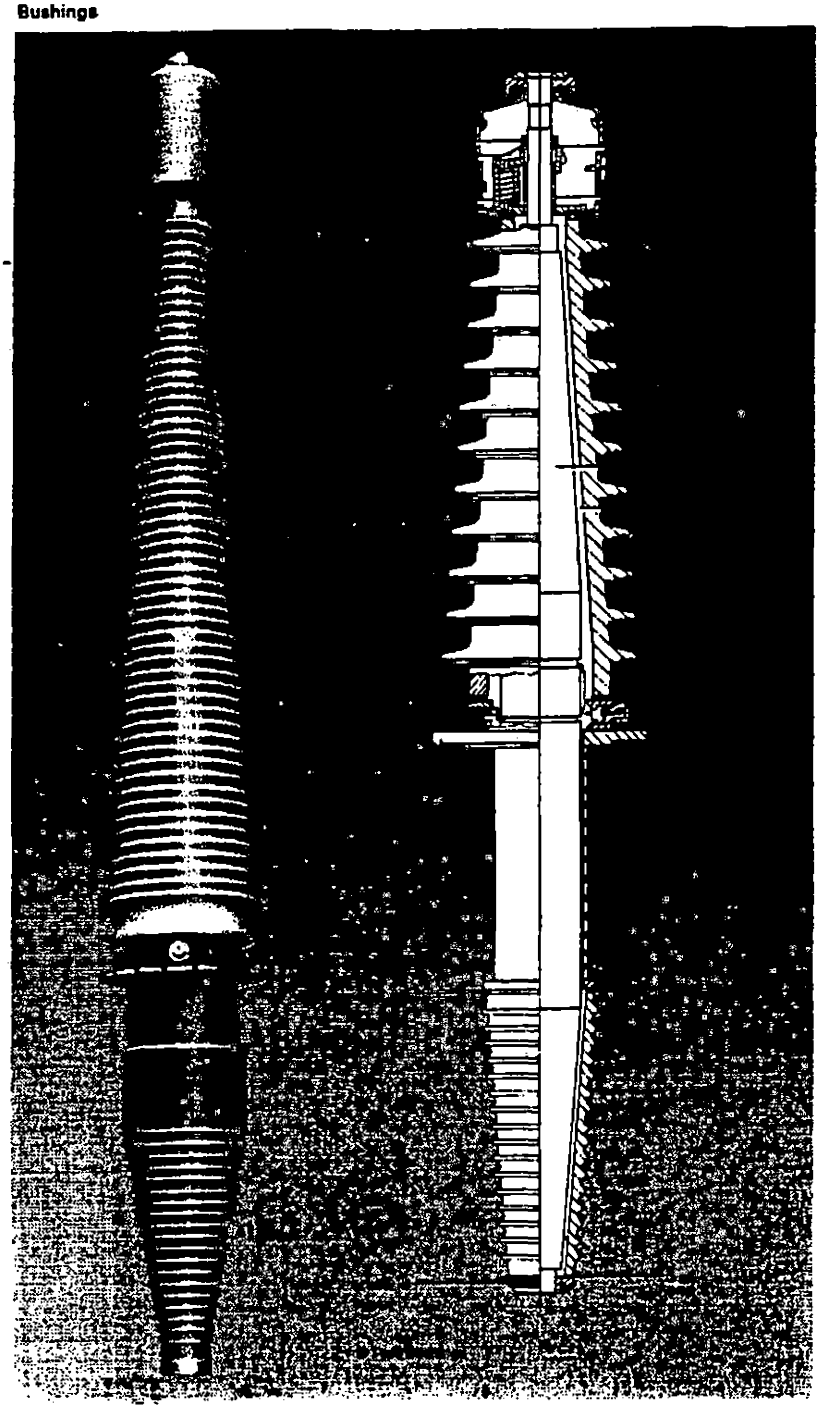
Alternate Corona Test
Corona test will be made on all transformers 345 KV and above by exciting them at 150% of the maximum system operating voltage for one hour. Single phase units will be excited from a single phase source and three phase units from a three phase source.

Corona readings will be recorded at 10 minute intervals for the HV terminals.

If all readings are 150 microvolts or less, the transformer is considered acceptable.

If the RIV level on any tested terminal exceeds 150 microvolts, additional testing will be performed to demonstrate the reliability of the transformer.

Bushings



Several designs of bushings are used on Westinghouse shell form transformers depending on BIL and current requirements. All designs comply with industry standards pertaining to electrical and mechanical characteristics.

O Bushings
The type O condenser bushings are designed for transformer and oil circuit breaker applications above 46 KV.

The bushing is constructed using an oil-impregnated Kraft paper condenser in an oil filled chamber. The oil chamber consists of an expansion bowl, upper and lower porcelains and a metal flange. The assembly is sealed and held under pressure by a spring assembly.

The flange is provided with a voltage tap receptacle and an oil valve.

OS Bushings
This bushing is applied to windings through 46 KV-250 KV BIL. The condenser is wound on the conductor tube using treated Kraft paper. Metal foil is inserted at appropriate diameters to form the condensers. A porcelain weather shield is solder sealed to the conductor tube and flange to protect the external portion of the condenser. The porcelain weather shield is filled with Wemco C Oil.

RJ Bushings
RJ Bushings are applied on transformer windings 15 KV and below. This design is applied primarily on tertiary windings of autotransformers and multiple winding transformers.

This bushing uses a lead encased in a single piece wet process porcelain. A one-piece forged aluminum flange is rolled into a groove in the porcelain over a silicone rubber gasket.

Bulk Type Bushings
Westinghouse bulk type bushings are designed for 25 KV, 150 KV BIL insulation level and are used as the primary lead connection on generator step-up transformers. The design features a single piece porcelain and integral metal flange with a heavy tubular lead through the center. A spring loaded retaining ring maintains the lead and porcelain assembly under compression.

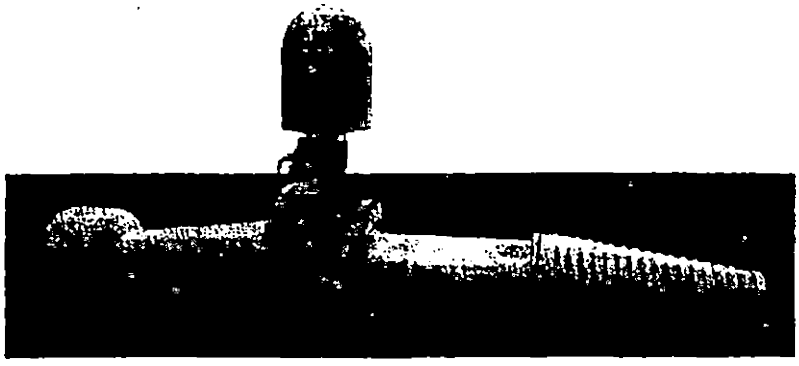
A four spade rectangular terminal is provided for external connection to bus duct leads. The inner assembly is vented to allow circulation of cooling oil from the transformer tank, and for this reason the internal end of the bushings is located below the oil level in the transformer tank.

All external porcelains for Westinghouse Bushings are available in either ANSI 70 Grey or Standard Brown.

NPC00007684



OS Type Bushings



SFO Bushing

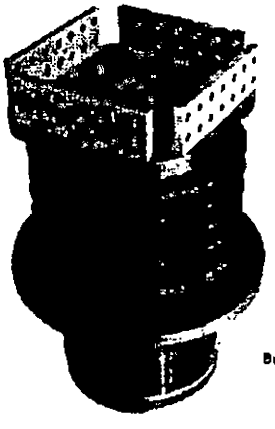


RJ Type Bushings

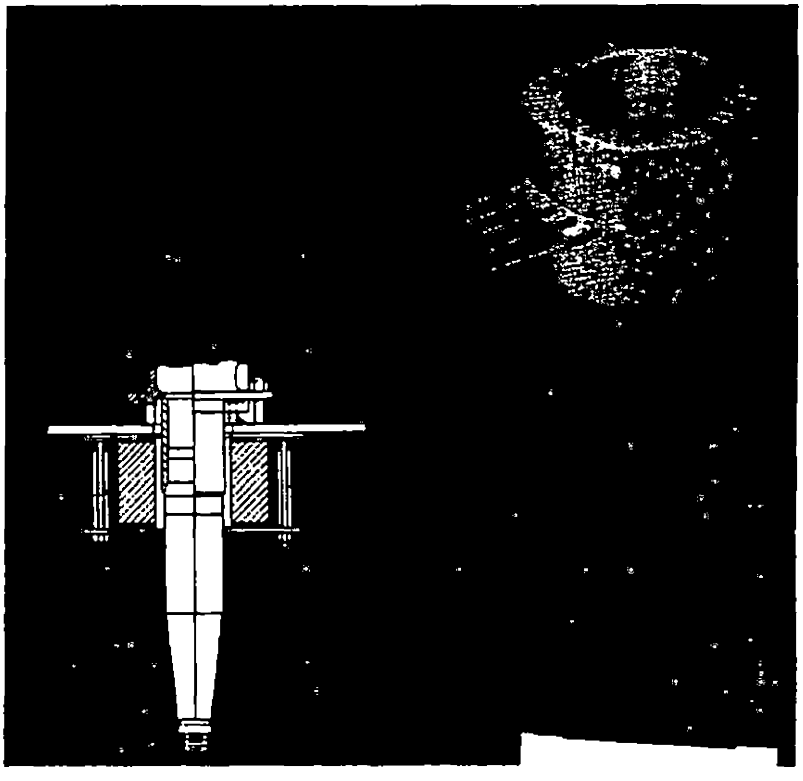
The Westinghouse type SFO Bushing provides a very reliable termination between an oil-filled transformer and a pressurized gas-insulated bus. The transformer can be connected directly to the other components of a GIS substation with the SFO bushing.

The bushing incorporates inner and outer castings of a high strength epoxy compound which is resistant to SF_6 gas. A double interface between the gas dielectric and the transformer oil is provided to prevent contamination of the transformer insulation.

The SFO Bushing incorporates many of the proven features of the type O Bushing such as the oil impregnated split foil condenser, the potential tap, a flange extension for mounting internal current transformers and a spring loaded lead assembly.

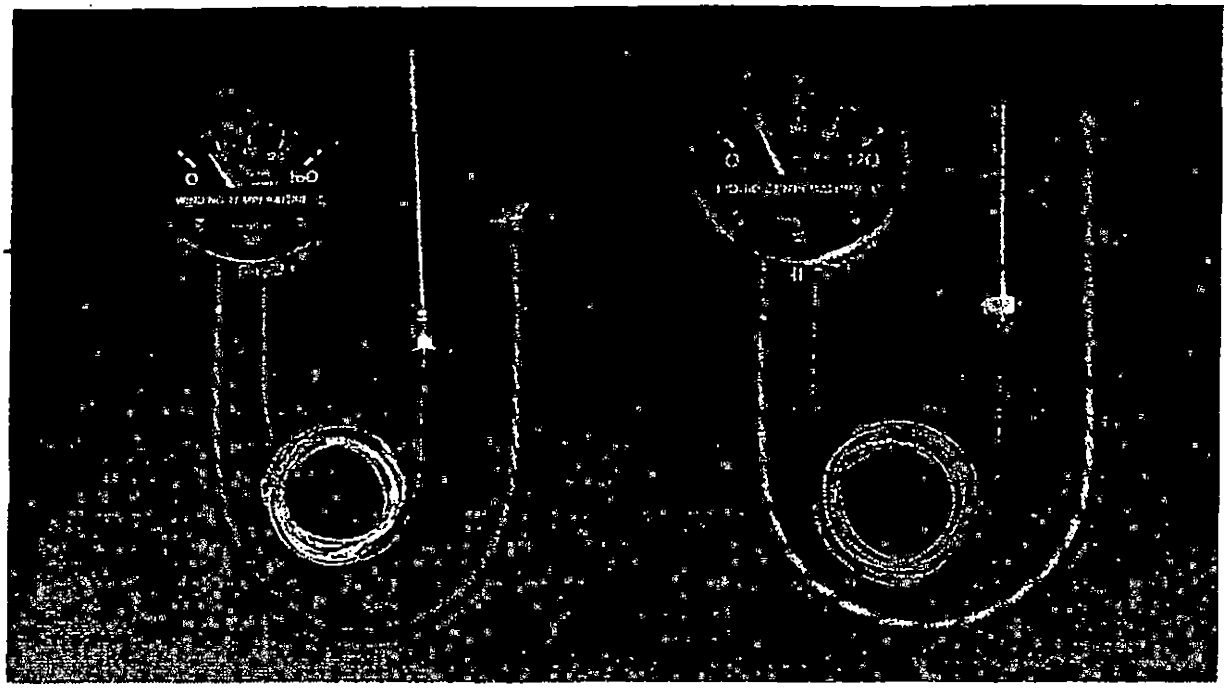


Bulk Type Bushings



NPC00007685

Electrical Accessories

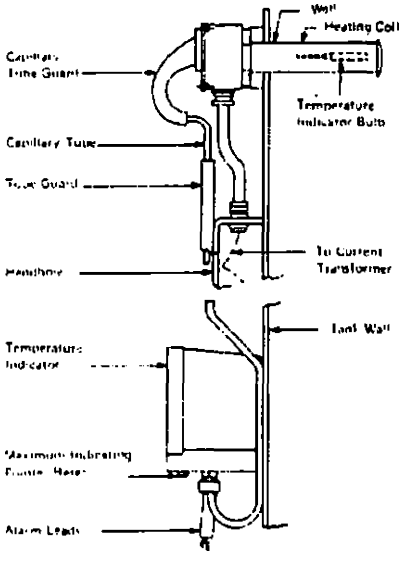


Winding Temperature Indicator
The Westinghouse hottest spot temperature indicator is an assembly utilizing a bourdon gauge, calibrated in degrees centigrade, connected to a bulb by a capillary tube. The indicator is located on the tank wall at eye level for convenient reading. The thermometer bulb and a heating coil are assembled in a well located in the hottest oil near the top of the transformer.

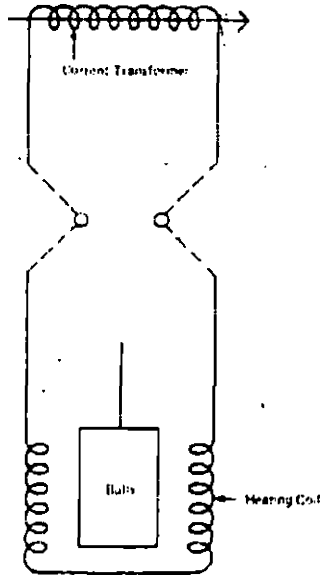
Current, proportional to the transformer load current, is supplied to the heating coil by a current transformer. This adds an increment of temperature to the thermometer bulb which is equal to the winding hot spot rise above hot oil temperature. Thus, the instrument indicates hot spot temperature.

Three switches are provided in the instrument to operate forced-cooling control and alarm circuits.

Oil Temperature Indicator
The liquid temperature indicator is mounted on the transformer tank at eye level height. The assembly utilizes a bourdon gauge connected to the bimetallic thermometer bulb by a capillary tube. The thermometer bulb is enclosed in a well located in the hottest oil near the top of the tank. Two switches are provided in the instrument for operation of auxiliary and alarm circuits.



Sectional View of Transformer Showing Mounting of Indicator with Flexible Tube

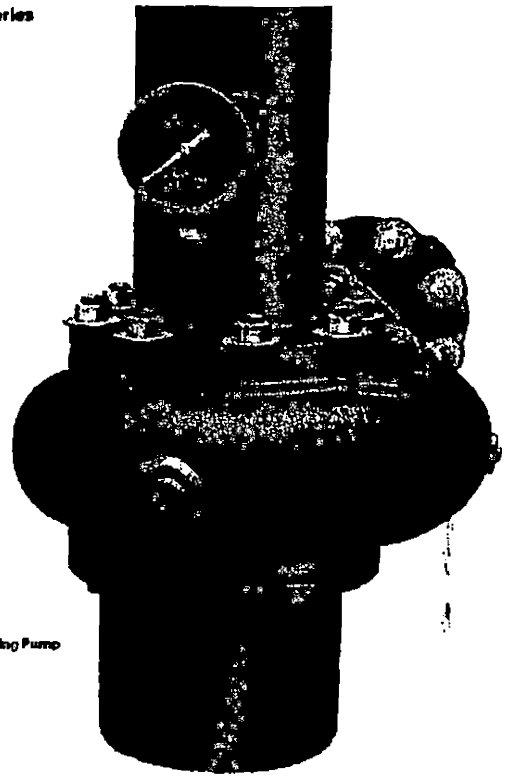


Connection Diagram for Current Transformer and Heating Coil

NPC00007686

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Thermal Accessories



Oil Circulating Pump



Oil Circulating Pumps

The circulating pumps supplied on Westinghouse forced cooled power transformers are a special centrifugal design using a close coupled pump and motor enclosed in a cast iron housing. The oil flow within the pump is directed to provide bearing lubrication and cooling for the motor stator.

The pump is suitable for multiple mounting positions and can be applied to all types of Westinghouse coolers or radiators.

Oil Flow Indicator

The Westinghouse oil flow indicator is a vane operated instrument designed for use with each forced oil pump on a transformer. It provides visual indication and confirmation by electrical alarm switches, of the proper operation of the pump and adequate oil flow for cooling.

The alarm switch leads are brought out through a threaded receptacle for connection to remote alarm equipment.

Liquid Level Indicator

The liquid level indicator designed for Westinghouse transformers is a self contained float operated instrument. The indicator is a two part assembly. The sealed body is attached to the tank wall and contains an actuating magnet shaft connected to the float arm inside the transformer. The bezel, or outer assembly, contains the calibrated dial and indicating needle. The indicating needle is directly connected to a second magnet which is positively displaced by the rotation of the magnet and float arm assembly in the sealed body. Alarm switches are enclosed in the bezel and alarm leads are terminated in a threaded receptacle from which they can be connected to remote equipment. No oil leaks can occur around the instrument because of the sealed body design.

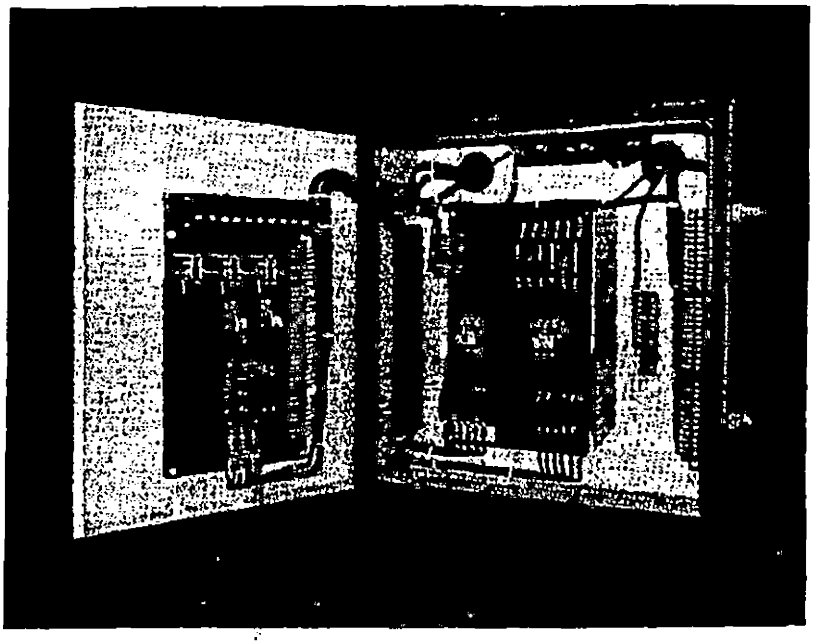
Westinghouse Insulating Oil WEMCO "C"

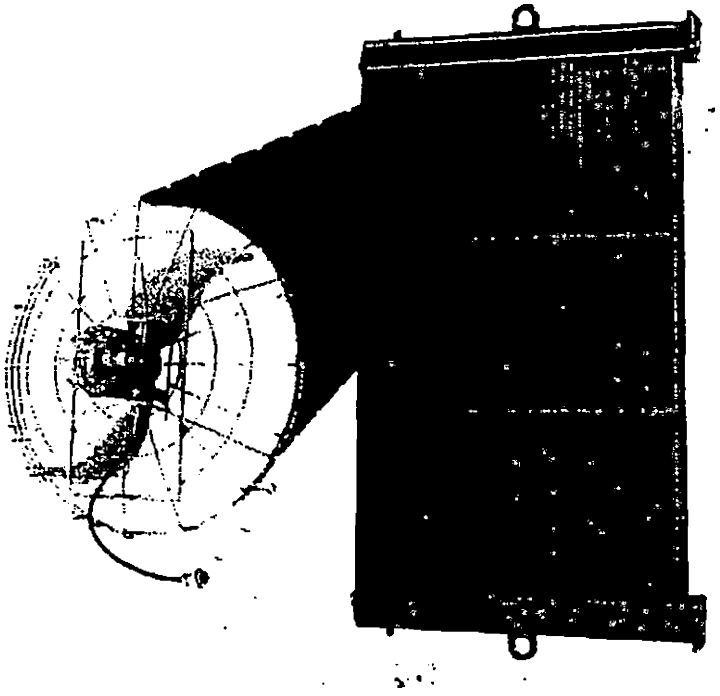
Concurrent with the Insuldur development, Westinghouse was working with the various petroleum companies to develop a higher flash-point oil for additional margin of safety. Westinghouse Research developed and provided to all of the oil suppliers the required information needed to refine a new higher flash-point oil and made it available to all the industry. The flash-point was raised from 275°F to 283°F while equalling or bettering the remaining characteristics including lower pour point.

NPC00007687

Thermal Accessories, cont'd.

Control Cabinet For Auxiliaries
Westinghouse transformers are equipped with a weatherproof control cabinet for termination of auxiliary equipment. Controls for the fans and pumps are actuated by winding temperature and provisions can be made for automatic or manual switching to an alternate auxiliary power source to assure continuous operation of cooling equipment.





Radiators
The Westinghouse radiator is an efficient cooling unit designed for use on large transformers requiring a self cooled rating. The radiator is detachable and is removed from the transformer for shipment.

The radiator is all welded sheet metal construction with vertical cooling sections through which the oil circulates and cools. A formed metal header is welded to each end of the vertical fin sections and provides the fittings to attach the radiator to the transformer tank.

Fans and pumps are used in conjunction with the radiator to provide forced cooled ratings.

Forced Air Fans
The fan assembly is designed specifically for use with Westinghouse radiators. Groups of fans are mounted on the side of a radiator bank and provide forced air circulation through the continuous ducts formed by the parallel mounting arrangement of the radiators.

The fan assembly consists of a fractional horsepower motor and glass reinforced polyester fan blade. The motor is mounted on a steel wireform bracket, which also serves as a guard for the fan blade.

Either three phase or single phase motors are *available and all motors are equipped with fit*tings for periodic lubrication.

NPC00007688

Thermal Accessories, cont'd.

FOA Transformer Cooling Equipment
Westinghouse FOA transformers are equipped with oil to air heat exchangers.

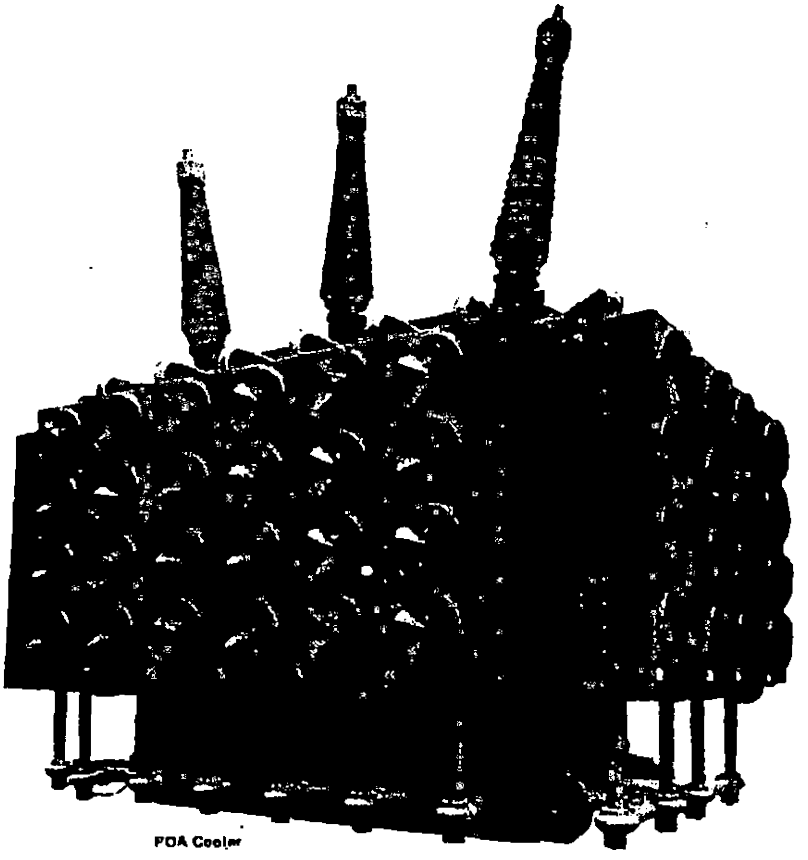
Efficient heat dissipation occurs as oil is pumped though the tube bundle and the fans draw air across the finned tubes. The air discharged by the fans is directed away from the transformer.

The FOA cooler is an assembly of a tube bundle and fans mounted in a steel housing. The tubes have extruded fins for increased radiation surface. The fans are thermally protected to prevent motor overheating.

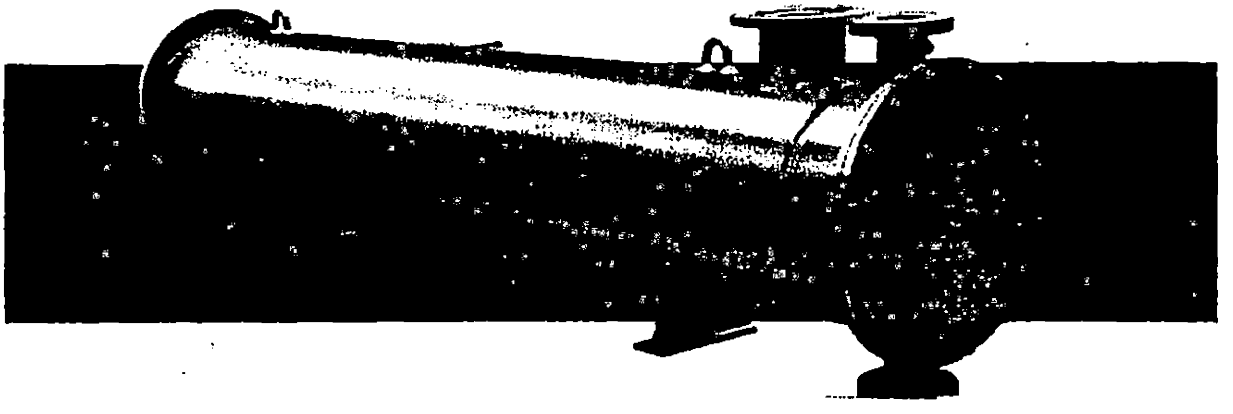
FOW Cooling Equipment
The Westinghouse oil to water heat exchanger is an efficient and compact method of cooling large power transformers and is used if a suitable source of cooling water is available. The cooler is constructed using double wall finned tubes encased in a steel shell.

Oil from the transformer is pumped through the shell around the tube bundle as water is circulated through the tubes. Heat from the oil is transferred through the cooling tubes and carried away by the discharged water.

The outer (oil side) of the cooler tubes is copper with extruded copper fins. The internal (water side) of the tubes is cupronickel alloy. The use of saline or raw river water is feasible because of this tube construction. Double wall construction between the water inlet and the oil shell prevents contamination of the oil.



FOA Cooler



NPC00007689

Standard Paint Finish
The paint finish on a transformer serves two purposes – to protect the exposed metal surfaces from corrosion and to enhance the appearance of the unit. The current emphasis on beautification has increased the use of colors that help to blend the units with the background at the installation site.

Several steps are followed in painting a Westinghouse transformer and its accessories:

The steel plate used to fabricate the tank is thoroughly cleaned of mill scale and corrosion by rotary blasting equipment.

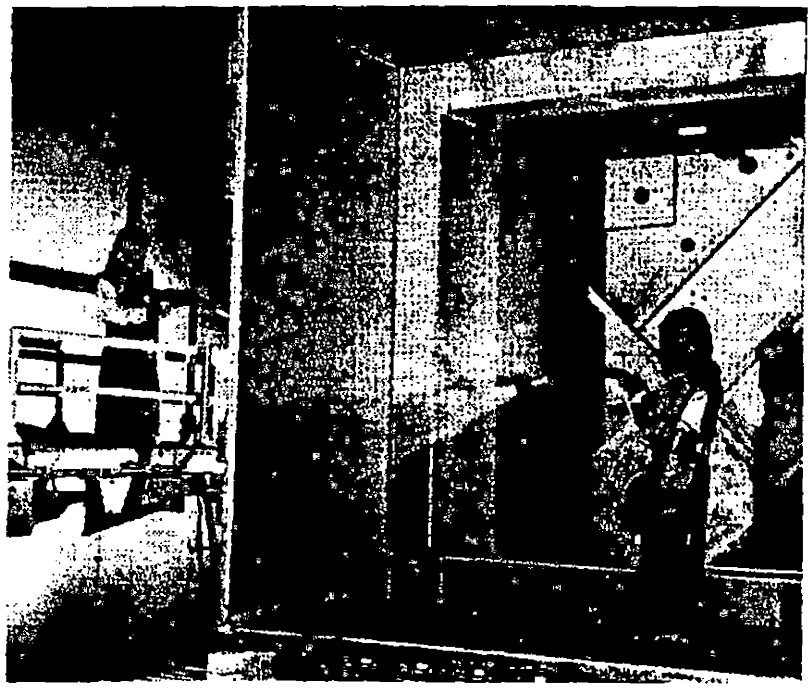
The complete tank is shotblasted for removal of weld spatter and other surface dirt accumulated during fabrication.

The tank is then painted using an "Airless Spray" process. A primer coat of alkyd vehicle and rust inhibitive pigment is applied followed by a finish coat of alkyd vehicle and pigments. Both coats of paint are air-dried to assure proper curing and adhesion to the metal surfaces.

A final touch-up coat of alkyd vehicle and pigments is applied to the completed transformer immediately prior to shipment.

Accessory items are painted separately using a similar process.

The standard color for Westinghouse large power transformers is ANSI 70 light Grey. ANSI 24 Dark Gray and ANSI 45 Foliage Green are available at additional cost. Nonstandard colors are also available at additional cost providing the material is compatible with Westinghouse primer.



Completed Tank in Shotblast Room for Touch-Up Cleaning



NPC00007690

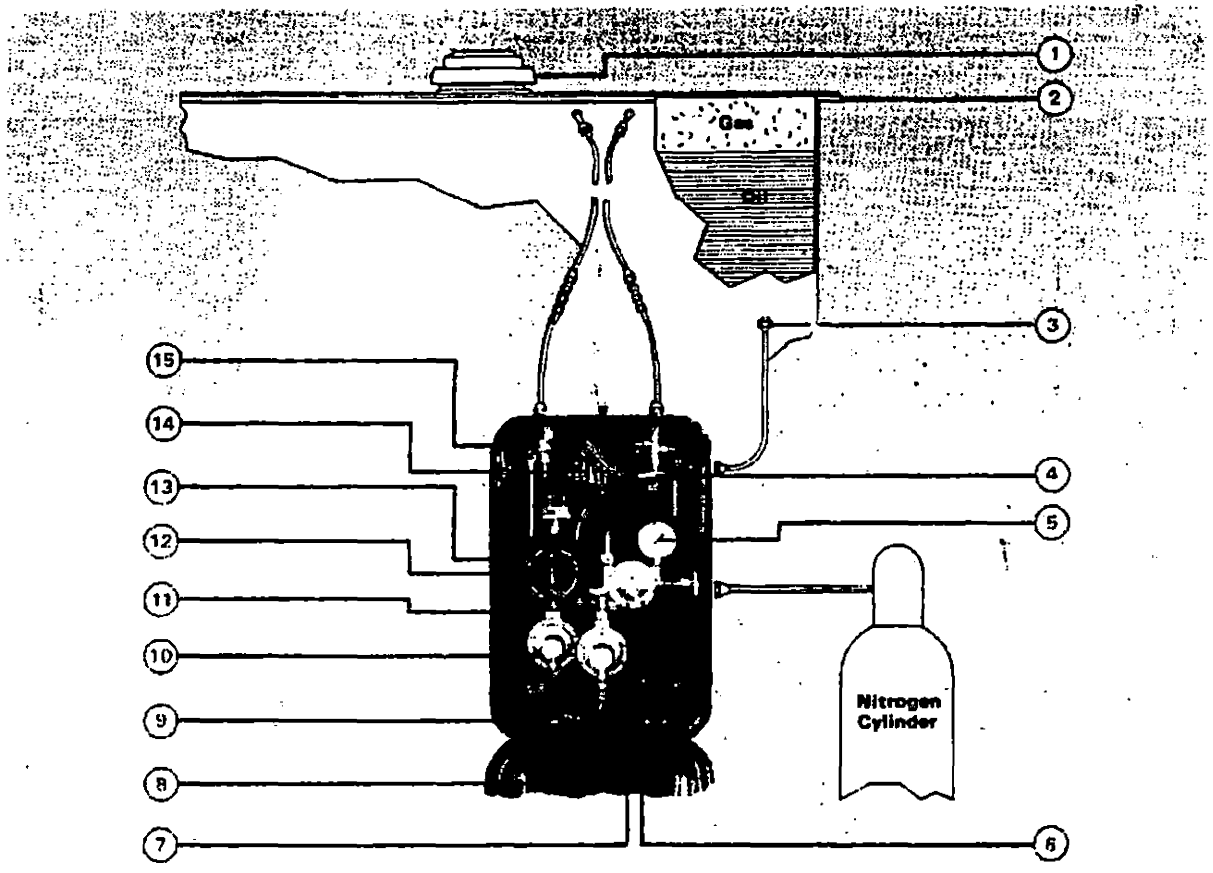
Inertaire Equipment

Westinghouse Inertaire equipment assures long insulation life and negligible oil deterioration by maintaining a cushion of dry nitrogen above the oil of the transformer. The nitrogen is supplied from a steel cylinder and is automatically fed into the transformer through a reducing valve whenever the internal pressure in the tank falls below ½ pound per square inch.

A relief valve incorporated into the controls conserves nitrogen in the gas space by permitting it to escape into the atmosphere only when the pressure in the transformer reaches a predetermined value.

A valve connected to the gas space provides a means of sampling the gas for oxygen content. A compound pressure gauge indicates internal tank pressure or vacuum.

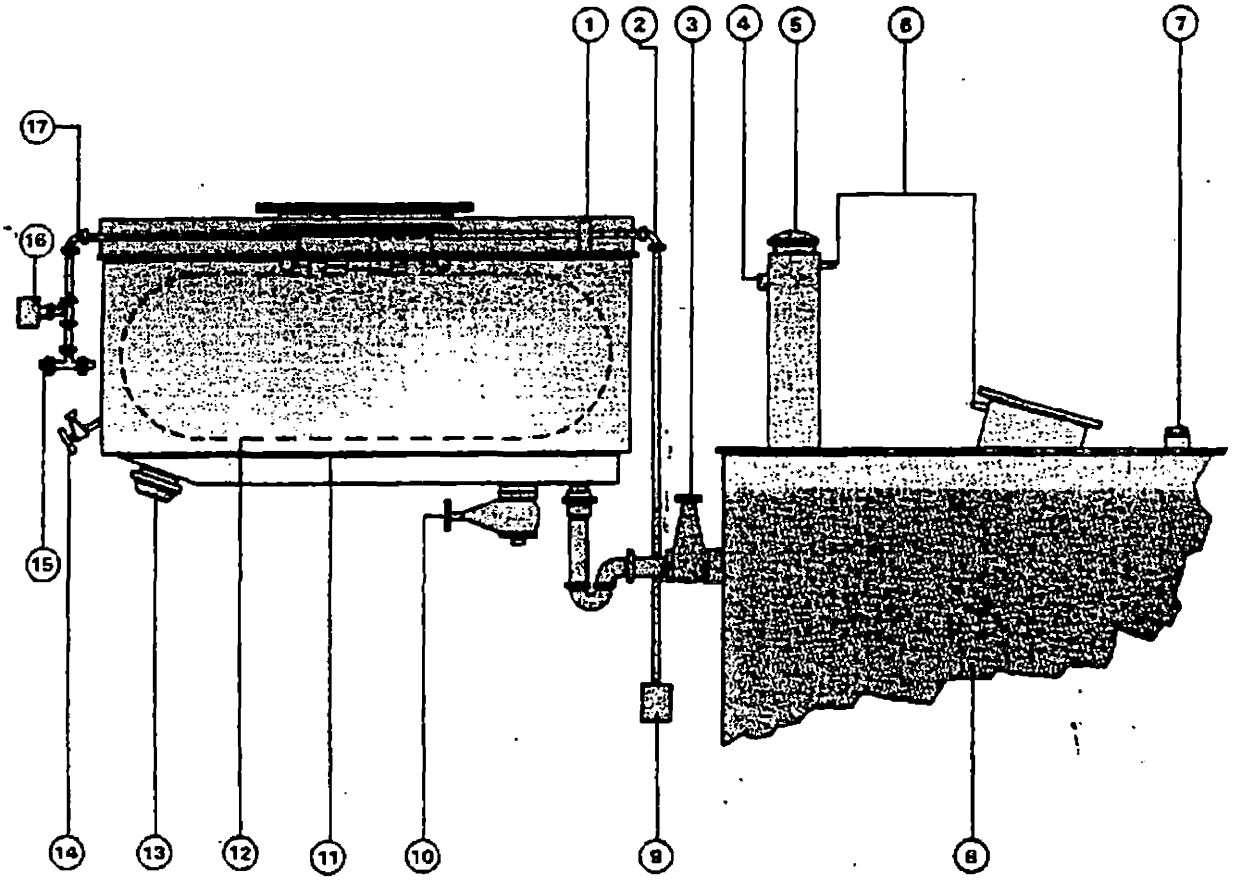
All equipment except the nitrogen cylinder is enclosed in a weatherproof cabinet with padlocking provisions.



1. Relief Device
2. Tank
3. Lead Conn.
4. Shut Off Valve
5. Cylinder Pressure Gauge
6. Second Stage Handle
7. Three Stage Regulator
8. Secondary Relief Valve
9. Drain Cock
10. Primary Pressure Relief Valve
11. Breather Sump
12. Transformer Pressure Indicator
13. Needle Test Valve
14. Terminal Block
16. Sampling Valve

NPC00007691

COPS



Constant Oil Pressure Oil Preservation System (COPS)

The Westinghouse Constant Oil Pressure System (COPS) of oil preservation maintains a constant pressure on the surface of the oil in the transformer. The tank and the oil are sealed from the atmosphere preventing exposure of the oil to oxygen and moisture.

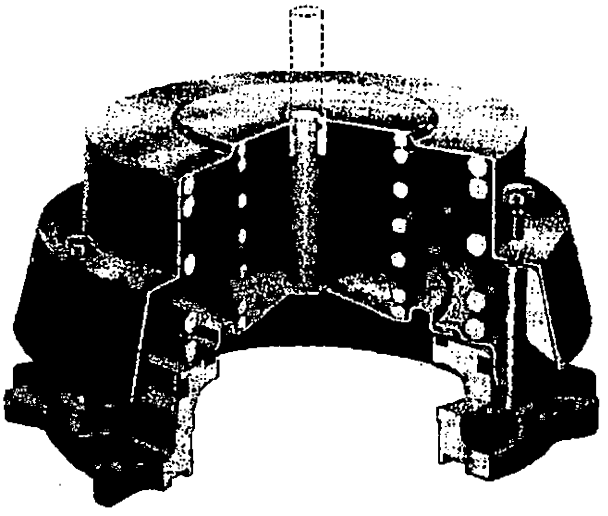
The oil expansion in the transformer, caused by thermal cycling, is absorbed into a steel reservoir mounted above the main tank. Contact between the oil and the atmosphere is prohibited by a flexible Nitrile air cell in the expansion reservoir. The air cell is vented to the atmosphere through a dehydrating breather and inflates or deflates as the oil volume in the transformer changes. Connection between the main tank and the reservoir is made through a globe valve, thus permitting isolation of the main tank.

1. 2 Inch Vacuum Plug
2. Breather Line From Air Cell to Dehydrating Breather
3. Globe Shut Off Valve
4. 3 Inch Vacuum Plug
5. Mechanical Relief Device
6. Vent Plugs
7. 3 Inch Fill Plug On Transformer
8. Transformer Tank
9. Dehydrating Breather
10. Drain and Fill Valve
11. Reservior
12. Air Cell
13. Liquid Level Gauge
14. Pressure-Vacuum Gauge
15. Pressure-Vacuum Bleeder
16. Vacuum Switch
17. Line Connecting Pressure-Vacuum Switch to Reservoir

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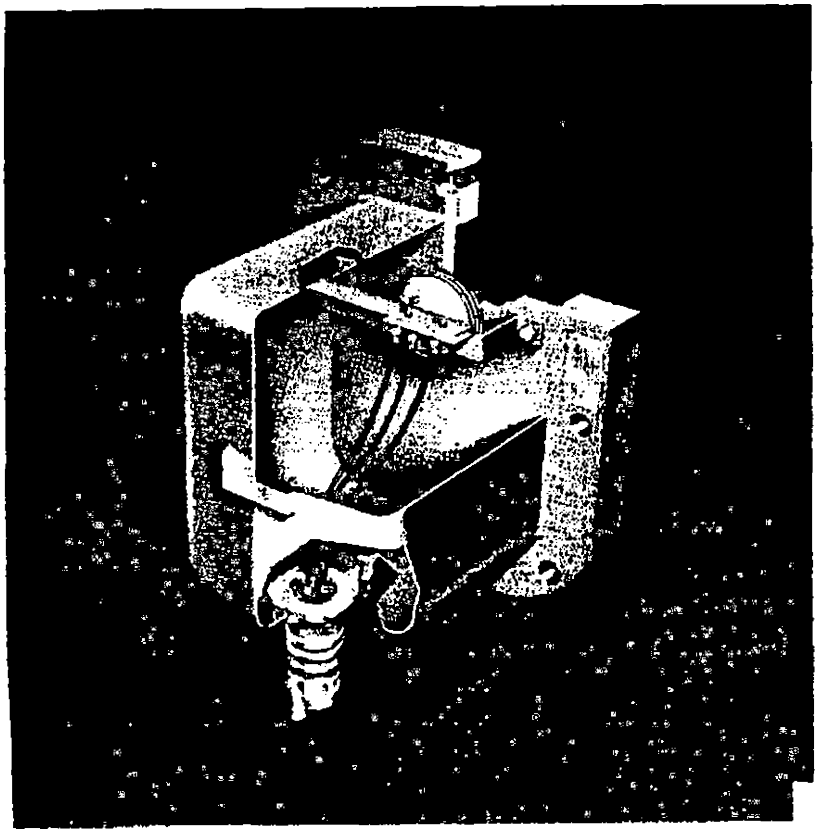
Protective Accessories



Automatic Resetting Relief Device

The Automatic Resetting Relief Device used on Westinghouse transformers is designed to relieve dangerous pressure which may build up within the transformer tank. When a predetermined pressure is exceeded, the reaction lifts the diaphragm of the relief device and vents the transformer tank.

The design features a dome-shape diaphragm, compression springs, gaskets and a protective cover. A lightweight plastic semaphore is used to indicate an operation of the relay. An alarm switch with contacts is available for remote signal of an operation. The compression springs reset the diaphragm on the gaskets following an operation thus preventing the entry of foreign material into the transformer tank.



Sudden Pressure Relay

The Westinghouse Sudden Pressure Relay is designed to respond to sudden increases in internal gas pressure in a power transformer. Normally, such pressure increases are caused by an internal arc and the associated circuitry of the relay can be arranged to initiate alarm and trip circuits to deenergize the transformer. Damage to the transformer can be minimized in this way.

The relay consists of a pressure sensing bellows, an alarm switch, and a pressure equalizing orifice, all enclosed in a sealed case. The relay is specifically designed for application with the Inertaire Oil Preservation System. It is mounted at the top of the transformer, at the gas space.

A seal-in relay, reset switch and other associated circuitry are mounted on a panel in the transformer control cabinet. A Voltrap® surge suppressor is connected across the trip contacts of the seal-in relay to prevent extraneous induced voltages in the alarm circuits from causing false operations. The relay is not affected by external mechanical shock or vibration.

Shipment
Westinghouse large power transformers are designed for shipment on the exclusive Schnabel railroad car.

Benefits of the Schnabel Car
- $5,000 to $10,000 savings in unloading expense:

  Reduces unloading time by 40 to 60%
  Eliminates the need for heavy mobile lifting equipment.

- $20,000 to $30,000 additional savings by eliminating tank sectionalization and internal disassembly for shipment.

- Minimizes the exposure of critical insulation structures to the atmosphere thereby enhancing transformer reliability.

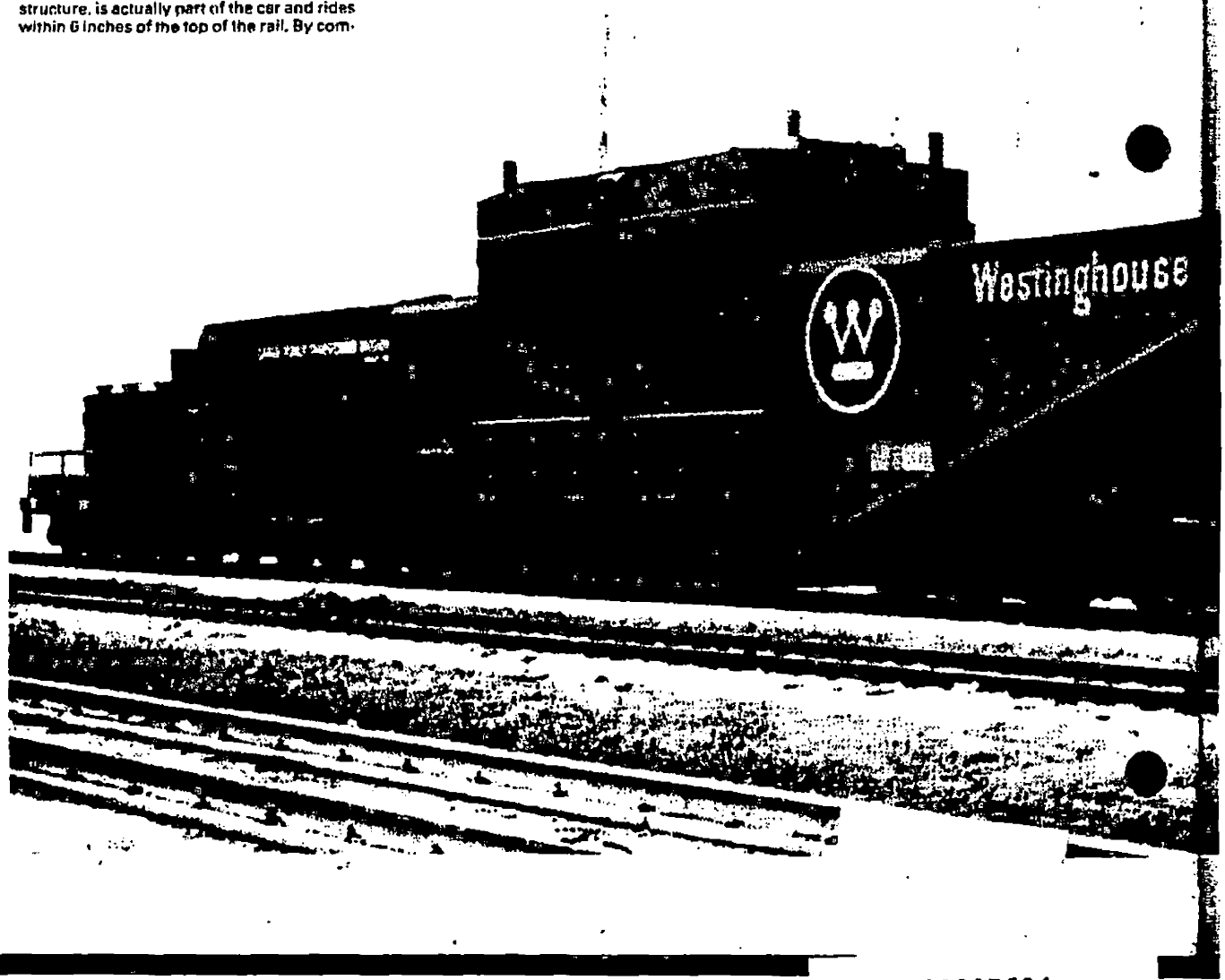
The transformer, loaded on the superstructure, is actually part of the car and rides within 6 inches of the top of the rail. By comparison the bed of a depressed center rail car is a minimum of 28 inches high, thus the effective shipping clearance height of a transformer is reduced 22 inches with Schnabel shipments.

This reduction in shipping clearance height eliminates the necessity of sectionalizing the tank for shipment and greatly reduces field assembly time. Since the tank need only be opened for installing and connecting the bushings, the atmospheric exposure is minimized and the transformer's reliability is enhanced.

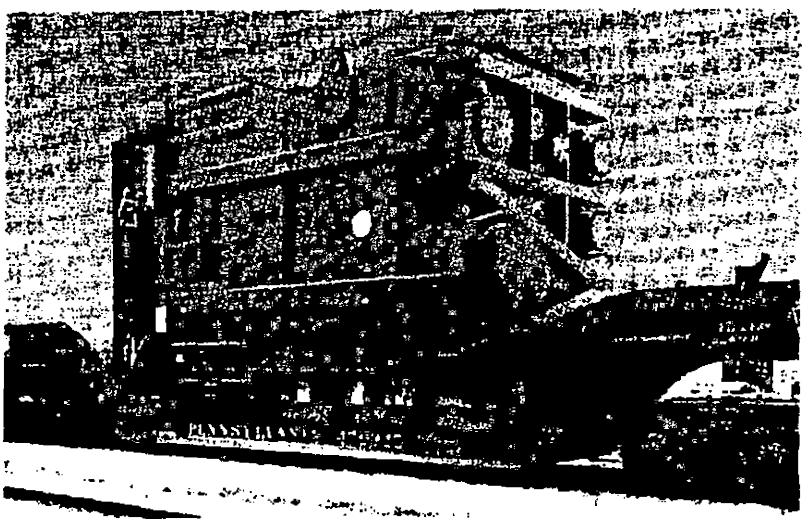
The pivot centers on the loaded Schnabel car are the same as a standard railroad box car, therefore it can negotiate standard railroad curves and does not require special routing.

The cars are equipped with a power driven hydraulic system and their own jacking system, facilitating direct unloading of the transformer without using heavy mobile lifting equipment. After the transformer is skidded to the pad the two halves of the empty car are coupled together for return to the factory. The unloading operation and moving the transformer onto its own foundation pad from an adjacent rail siding can be completed in an 8-hour working shift with a minimum of labor.

Westinghouse has three cars available (500,000 pound, 750,000 pound and 1,000,000 pound capacities) for maximum flexibility in scheduling transformer shipments.



NPC00007694



Single Phase Shipment

Single Phase Transformer Shipment
Westinghouse single phase large power transformers are frequently shipped on their sides because of shipping clearance limitations. Single phase designs are used primarily on EHV applications where the tank dimensions are high and narrow. Shipment of the transformer on its side eliminates the necessity of sectionalizing the tank and disassembling internal parts of the transformer.

The construction of shell form, form fit transformers is ideal for this method of shipment because the core and coils are a strong unit assembly, securely clamped and supported by internal structures of the tank.

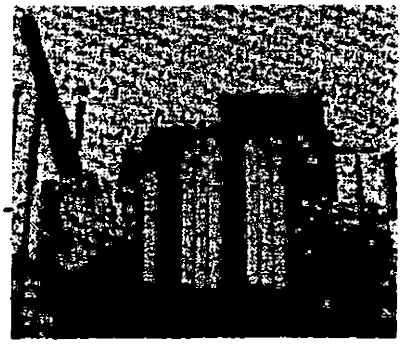
Uprighting the transformer at the installation site can be done by several methods – the most common being with a mobile crane. A specifically designed transformer rocker device is available which reduces the necessary lifting capability to approximately ten per cent of the shipping weight of the transformer.

Three Phase Shipment – Schnabel Car



NPC00007695

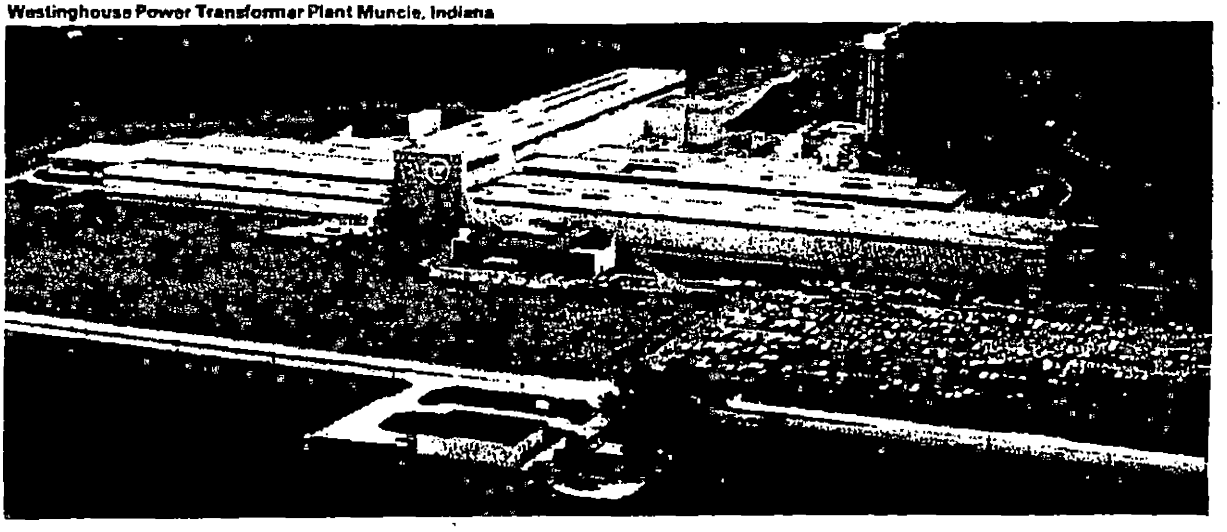
Westinghouse Developments for Power Transformers



1100 KV Transformer

1886 George Westinghouse granted first American transformer patent.
1906 Silicon Steel.
1907 Condenser bushings.
1921 220,000 volt power transformer with no load tap changer.
1924 Load tap changers.
1928 Surge generator for power transformer testing.
1929 Sealedaire oil protection for power transformers.
1931 Commercial impulse testing.
1932 Forced oil cooling (railway); Hipersil steel; vacuum filling of transformers.
1940 Solder seal bushings.
1942 Type "O" oil filled condenser bushings.
1943 Form fit tank.
1946 500 kv Tidd transmission line transformers (experimental).
1950 Coastal finish paint.
1952 220,000 kva power transformer.
1953 345,000 volt power transformer.
1954 400,000 kva power transformer.
1956 World's largest sound testing laboratory; power transformer designed by computer.
1957 Schnabel railroad car.
1958 Insuldur insulation system.
1960 Resistance type tap changer for high voltage applications.
1961 750 kv Apple Grove transmission line transformer (experimental); first transformer shipped from Muncie plant; 750,000 lb. capacity Schnabel car.
1962 Contract signed for 500 kv commercial system; 600,000 kva transformer shipped.
1963 Order received for 725,000 kva, 345 kv three phase transformer.
1964 First 500 kv transformer for commercial use shipped; new improved Insuldur.
1965 First 735 kv transformer for commercial use shipped.
1967 Order received for 1,000,000 kva transformer.
1968 950 Mva 3 phase transformer shipped; first 765 kv transformer and reactor for commercial operation shipped.
1969 First 1100 kv transformer (experimental) shipped; 1,000,000 lb. capacity Schnabel car.
1970 1,000,000 kva transformer shipped.
1970 Second 1100 kv transformer (experimental) shipped.
1971 Order received for 1,300,000 kva, 345 kv three phase transformer.
1972 Westinghouse announces 10 Year Warranty on Core and Coils of Shell Form Transformers.
New Laboratory facilities completed for use in insulation development and magnetic field studies.
SFO Bushing developed for use on transformers in GIS substations.
1973 1,300,000 KVA, 345 KV transformer shipped.
Third 1100 KV transformer shipped.
600 MVA, 230 KVA Phase Angle Regulator (World's largest) shipped.
1974 Order received for three 1100 KV transformers for prototype substation.

Westinghouse Power Transformer Plant Muncie, Indiana



This modern manufacturing facility was designed and constructed specifically for manufacturing large power transformers. Proven manufacturing concepts are combined with innovative processing techniques to produce a reliable transformer in a minimum cycle time. Sophisticated test equipment and procedures are utilized to prove the reliability of the transformer prior to shipment.

The plant is staffed with highly trained, experienced personnel. Complete Engineering and Development facilities are included as an integral part of the operation and are fully supported by the extensive Westinghouse Corporate Research Department.

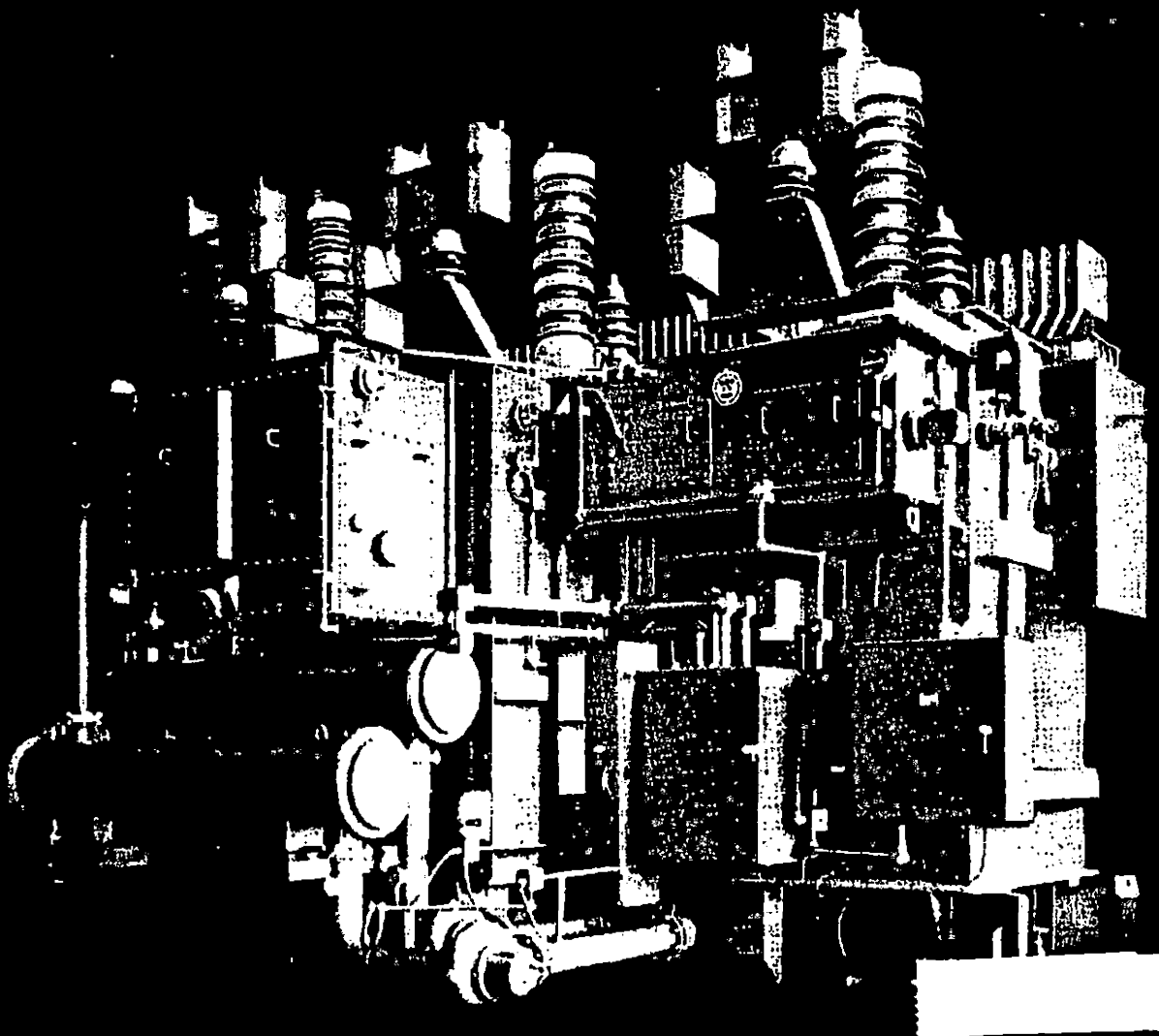
Westinghouse Electric Corporation
Large Power Transformer Division
Muncie, Indiana 47305 USA

Printed in USA

NPC00007696

770335

Shell Form Furnace Transformers



NPC00007697

Westinghouse Furnace Transformers are a special application of power transformers converting the high voltage input from conventional power sources to the low voltages and high currents required by electric furnaces in electro-metallurgical and electro-chemical processes. Transformer reliability is the foremost consideration in these applications.

Successful application of a transformer to an electric arc furnace installation requires the solution of several technical problems, both in design of the transformer and later in its operation as a power supply for the Furnace Electrodes. For example, during the early meltdown period of furnace operation, scrap metal may cave in around the electrodes and cause momentary short circuit currents to be drawn from the supply system. As the furnace electrodes are lowered into the scrap, momentary single phase loads occur on the transformer as arc ignition occurs between electrodes.

Switching transients and possible harmonic voltages and current amplification must be considered in the transformer design, particularly with the widespread application of vacuum breakers in the furnace transformer supply circuit.

The furnace transformer is subjected to heavy thermal overloads during the initial meltdown period of the furnace cycle which must be considered by the transformer designer.

Westinghouse Shell Form Furnace Transformer design satisfies the three basic criteria of Mechanical Strength, Dielectric Capability and Thermal Capacity and assures reliable furnace system operation.

(1) HV Surge Capacitors

(2) HV Surge Arrester

(3) HV Bushing

(4) Motor Operated No Load Delta/Wye Switch

(5) LV Bus Bar Bushing

(6) Lifting Hooks

(7) Delta/Wye Switch Motor and Control Cabinet

(8) Control Cabinet

(9) Inertaire Cabinet

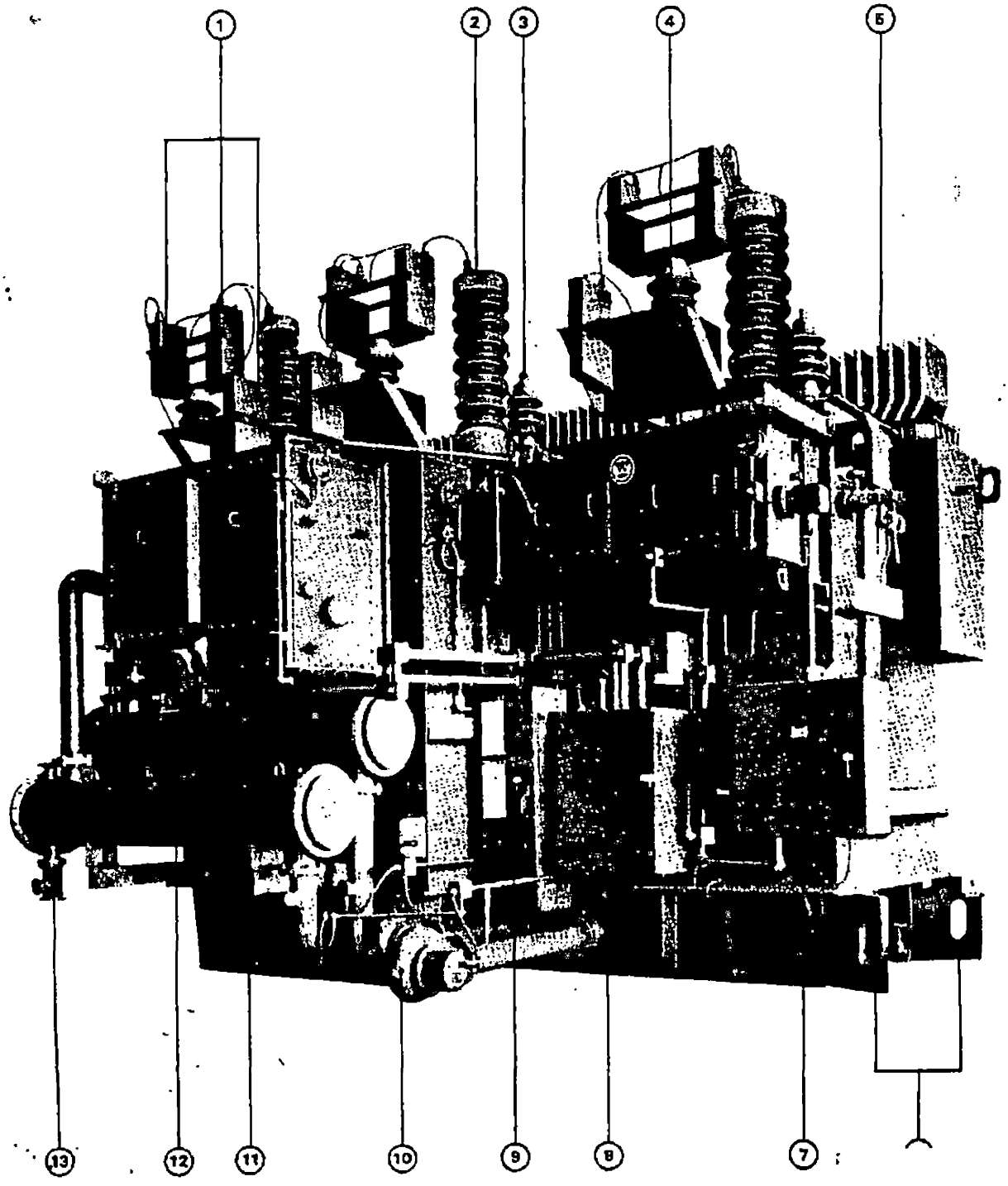
(10) Oil Circulating Pumps

(11) UVT Load Tap Changer

(12) FOW Coolers

(13) Cooling Water Connection and Water Flow Indicator.

NPC00007698



NPC00007699

Mechanical Strength

Significant benefits and advantages of the mechanical strength of Westinghouse Shell Form—Form Fit Furnace Transformer design:

- Up to 40% reduction in weight.
- 30 to 40% less floor space required.
- As much as 50% less oil volume.
- 15-20% reduction in total installation costs because of reduced vault space and lighter structural support members required for the transformer.
- 30-40% greater mechanical strength.

Westinghouse Shell Form Furnace Transformers incorporate over 70 years of experience in areas of design, fabrication and knowledge of material processing and testing to withstand the severe mechanical stresses imposed by Arc Furnace service.

- Westinghouse has successfully applied the mechanical principals of shell form, form fit designs to furnace transformers rated in excess of 175,000 KVA.

The problems associated with furnace transformer mechanical strength and short circuit capability have been receiving increased attention from both Furnace Builders and Users. This attention is well justified by the critical impact of possible transformer thru-fault failures on furnace operation. System conditions have been changing in a direction which has increased the exposure to, and magnitude of, system faults. Increased system capabilities, larger furnace capacities and reduced effective transformer impedances all tend to increase the magnitude of thru-fault currents and the resulting mechanical stress on the transformer coil system.

Three specific design criteria; magnitude of forces, magnitude of stress and mechanical strength all contribute to the inherent mechanical capability of the shell form, form fit design.

Shell Form-Fit Construction

The LV coils in a Shell Form Furnace Transformer are constructed of solid copper bars with welded joints. Each coil is separately terminated in the LV bushing.

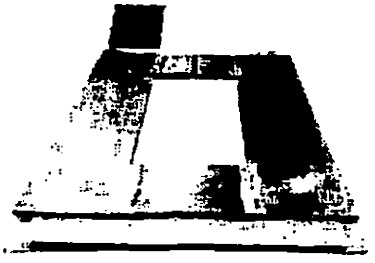


Figure 1M—LV coil group showing Bus Bar Coil.

The HV coils in the shell form design are large surface area pancake coils. Both the HV and LV coils are assembled into winding groups with their faces adjacent to flat pressboard washers containing a planned pattern of spacer blocks cemented to the surfaces giving a relatively uniform support system for the turns and strands of the HV coils and the solid copper bars of the LV coils. The complete phase is installed vertically in the tank bottom and the core iron stacked around it. The upper section of the tank is fitted snugly over the core by shimming under the vertical wooden slats around the external periphery of the core.

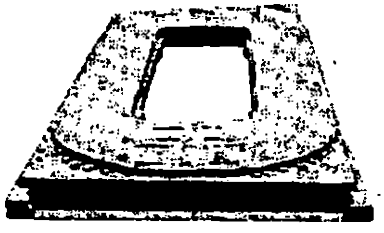


Figure 2M—HV coil group showing pancake coil.

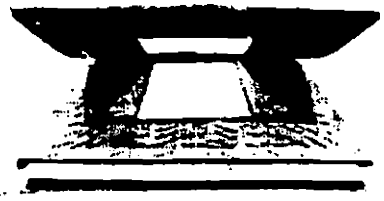


Figure 3M—LV coil group showing pressboard insulation washer and spacer blocks between coils.

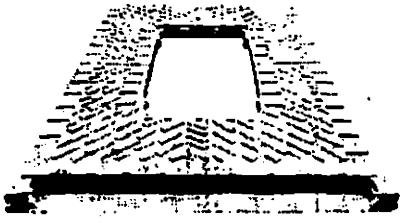


Figure 4M—HV coil group showing pressboard insulation washer and spacer blocks.

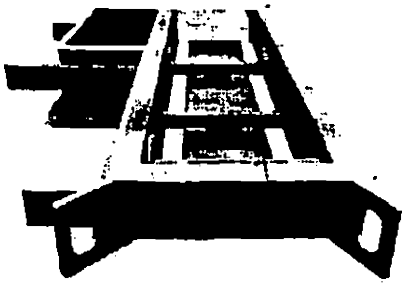


Figure 5M—Tank bottom section of a three phase Furnace Transformer.

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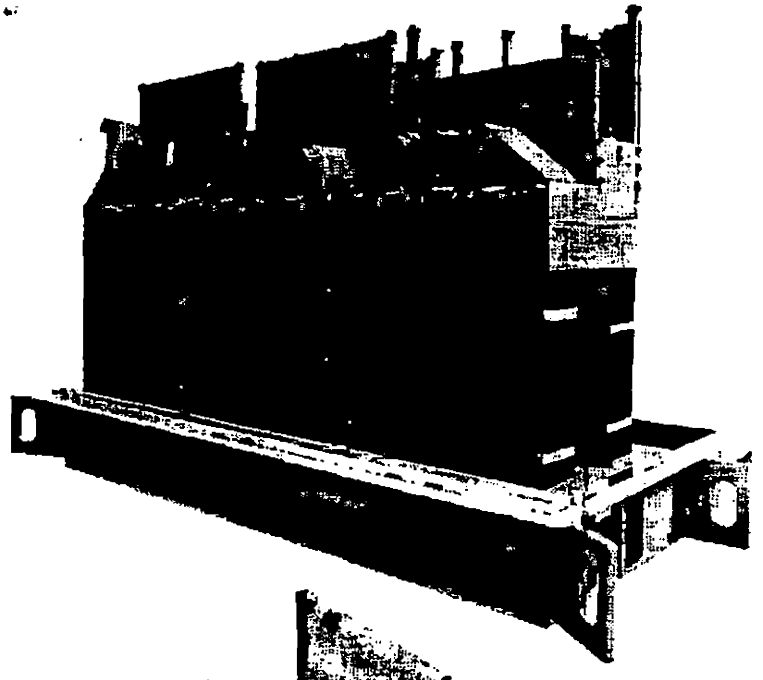


Figure 6M—Tank bottom section with phases installed and blocked.

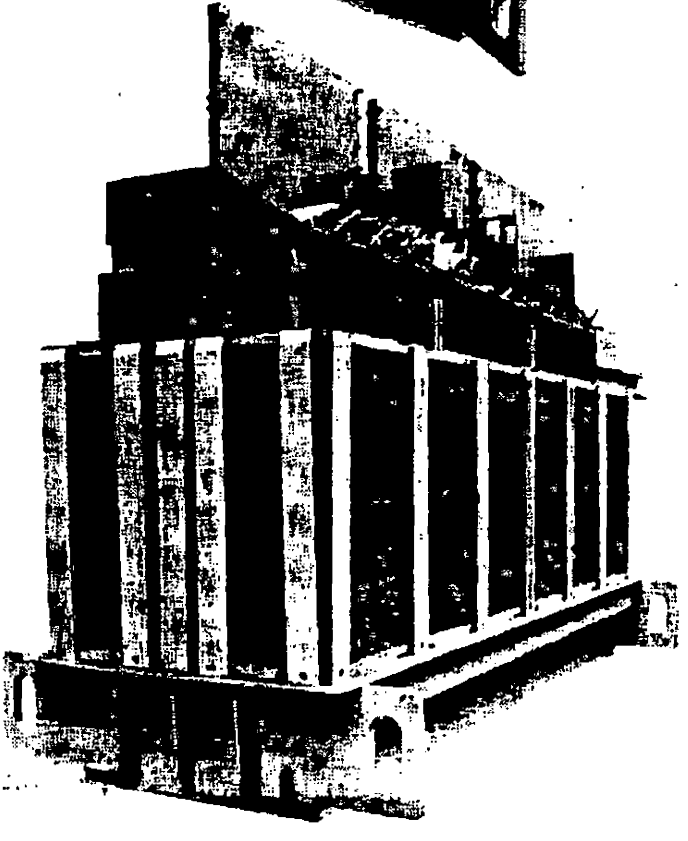


Figure 7M—Core and Coil assembly of a Shell Form Furnace Transformer.

Magnitude of Forces

The total force between transformer winding groups varies as the square of the ampere turns per group. Thus if the short circuit current is ten times the normal load current the short circuit force will be $(10)^2$ or one hundred times the normal load winding forces. This would indicate, as transformers get larger it is desirable to reduce the ampere turns per winding group to control the magnitude of total force. This can be accomplished by increasing the number of winding groups, commonly referred to an increasing the number of high-low spaces. Increasing the number of high-low spaces does not increase the average mean turn length of the windings, and can be done economically in Shell Form Transformers. To clarify this somewhat, consider the change in going from a two high-low to a six high-low arrangement with no other changes.

It is well to note that while each group in the two high-low arrangement, Figure 8M, experiences a total force F, the successive group forces, as we traverse the windings, are in opposite directions and tend to cancel each other. As a result the net total restraining force F'_R which must be applied external to the windings is only the force corresponding to a single pair of winding groups.

If we kept everything else the same but subdivided the ampere turns from 2 to 6 groups in each winding we would obtain the force relationships indicated in Figure 9M. The force on each group is now one-ninth its previous value since the force varies as the ampere-turns squared.

Westinghouse Shell Form Furnace Transformers utilize multiple high-low configurations. Six, eight and ten high-low designs are used as MVA ratings are increased with corresponding reductions in the forces between windings, thus limiting the total force magnitude on the individual coils.

Magnitude of the Stresses

In addition to the control of total force magnitude available in shell form, form fit furnace transformers, there is additional capability for keeping the unit stresses to lower levels. In transformers the forces throughout the windings and between the windings and the core or tank structures must be taken by cellulosic materials in compression. If these stresses become excessive the cellulosic materials will be crushed and the winding deformed and loosened under thru-fault conditions.

The major winding force component is perpendicular to the face of the pancake coils. Each coil is uniformly supported by spacer blocks on its adjacent pressboard washers. Between spacers the winding turns act as uniformly loaded beams as indicated in Figure 10M. The total winding force is transmitted through the group by the compression of the spacer blocks. Since the shell form design uses large area pancake coils a large number of spacer blocks are available to take the total force resulting in relatively low unit stresses in the pressboard both within the winding groups and external to the winding.

Mechanical Strength

The total force magnitude is reduced considerably in the shell form design by use of multiple high-low winding arrangements. Even with this advantage it is still essential to have a rugged mechanical structure to withstand the ultimate forces encountered. In the shell form design the major components of force are taken by well braced structures completely outside the winding assembly itself. The close fitting form-fit tank and core assembly both combine to restrain the forces on the winding portions within the iron opening. Above and below the core iron large heavy channels welded to the tank provide the restraint for the remaining portions of the windings. Since the bracing structures are completely outside the winding it is possible to reinforce them without the need for any compromises in winding design.

The Westinghouse Shell Form—Form Fit design offers a combination of controlled maximum stress and high mechanical strength to withstand the forces produced during furnace operation and during thru-fault conditions.

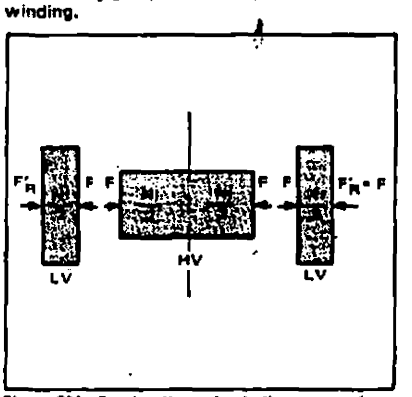


Figure 8M—Section through winding group of a two high-low coil arrangement.

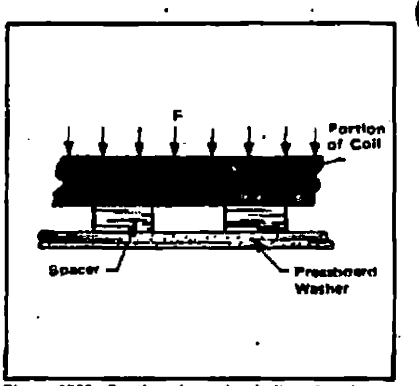


Figure 10M—Section through winding showing portion of coil and adjacent pressboard washer.

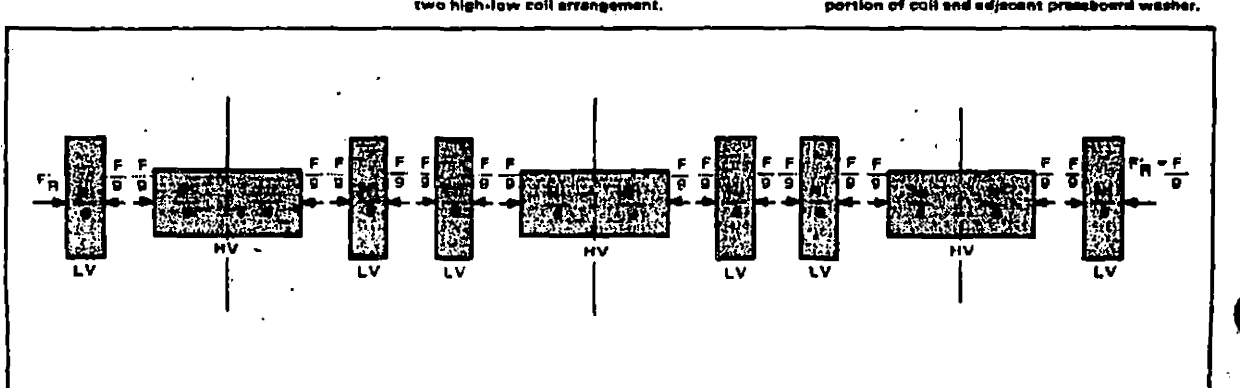


Figure 9M—Section through winding group of a typical six high-low coil arrangement of a Furnace Transformer.

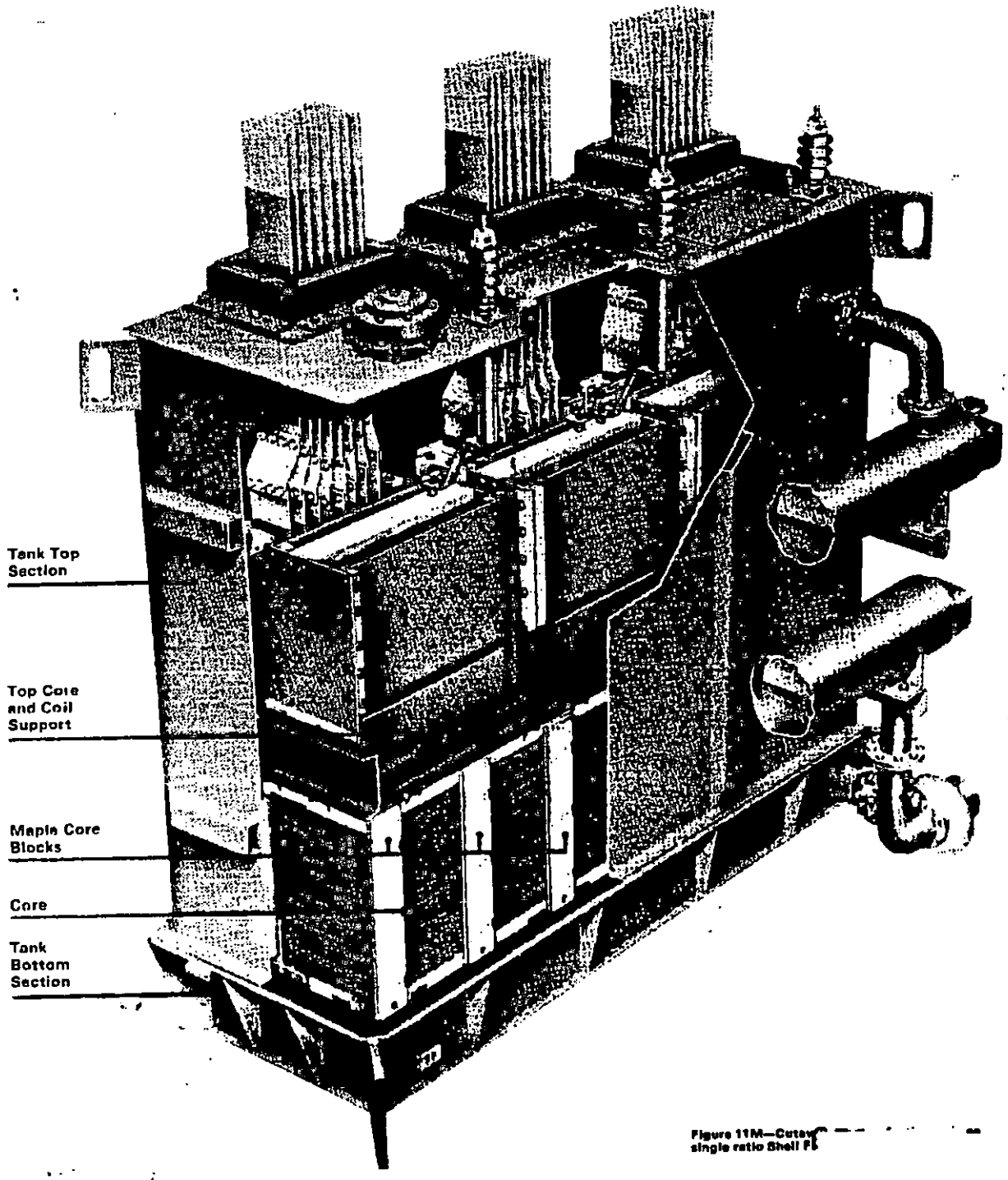


Figure 11M—Cutaw
single ratio Shell F

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Dielectric Capability

Significant benefits of the Dielectric Capability of Westinghouse Shell Form, Form Fit Furnace Transformers.

- The inherent high coil-to-coil and low coil-to-ground capacitance ratio provides uniform distribution of surge voltage over the entire coil system.

- Insulation structures are predesigned and strategically placed to utilize the oil impregnated pressboard insulation in puncture rather than creep for up to 300% additional strength.

- Taps and line end connections are made at the top of the coil with short predesigned leads thus minimizing the effect of localized heating because of high fields. The LV coil group bus connections are of nearly uniform length thus eliminating any impedance unbalance in the bus structure.

The design of a power transformer requires careful consideration of the electrical transient overvoltages to which the transformer may be exposed. Transformers for use in electrical arc furnace circuits, because of the nature and operation of the arc furnace, can experience many more transients than in most other electrical power circuits. The action of the electric arc, especially during furnace operation in the early meltdown state when the electrode currents are momentarily extinguished and reestablished (Figures 1D & 2D), creates transient and harmonic voltages. The application of large switched shunt capacitor banks for power factor correction in electric arc furnace supply circuits can also lead to a variety of switching transients and cause amplification of harmonic voltage conditions.

The growing use of vacuum switches and breakers in the electric arc furnace circuits has raised additional considerations of overvoltage generation. Certain vacuum switches have the tendency to prestrike and restrike (Figure 3D), or to chop current, which causes high frequency voltage and current oscillations. These oscillations represent the exchange of energy between the inductances and capacitances in the circuit. Where the energy is large and the capacitances small a high-frequency transient overvoltage can result which, without proper transformer characteristics and overvoltage protection, may damage transformer insulation.

Westinghouse recommends the use of surge capacitors, mounted as close as possible to the HV terminals, to increase the terminal capacitance and reduce the magnitude of these transient overvoltages. The use of surge arresters is also recommended to absorb much of the energy in the oscillating circuit and reduce the exposure to the transformer windings (Figure 4D).

The effect of the various overvoltages and high-frequency transient conditions on the windings of the transformer is determined by the characteristics of the particular coil and winding system. As these transients enter the transformer winding, the initial voltage distribution will be directly determined by the capacitance network of the coil and winding system. Oscillations may develop as the transient progresses through the coil system, which for certain designs may be amplified by the natural oscillation in these systems to a value greater than the initial crest (Figure 5D). This overvoltage condition may concentrate at some point in the winding, such as the first several turns at the line end of the winding and stress the turn-to-turn insulation in these areas.

The coil assembly of a Westinghouse Shell-Form Furnace Transformer consists of a relatively few "pancake" coils with a broad cross-sectional area and a narrow coil edge (Figure 6D). Since the capacitances between coils and from coil to ground are directly proportional respectively to the cross-sectional area of the coil and the area of its edge, the Shell-Form Coil System has a high coil-to-coil and

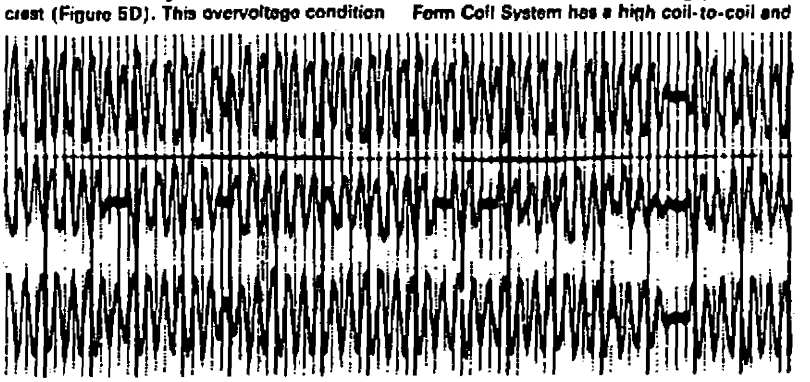


Figure 1D—Oscillogram of primary phase currents into an Arc Furnace Transformer during the initial melt period.

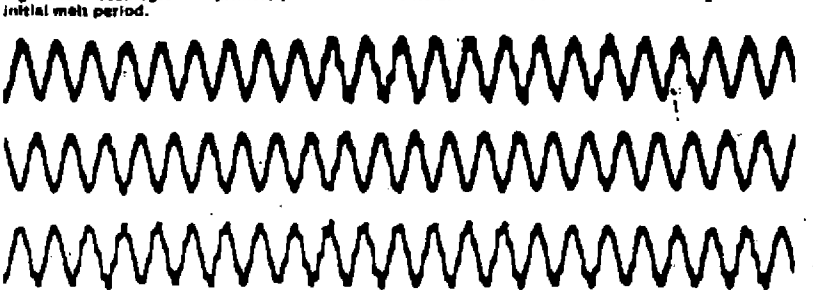


Figure 2D—Oscillogram of line-to-ground voltages on the primary side of an Arc Furnace Transformer during the initial melt period.

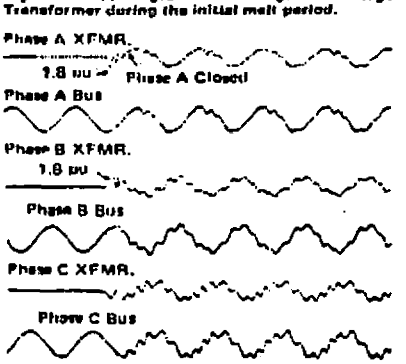


Figure 3D—Oscillogram of transformer and bus voltages during energization with a vacuum breaker showing multiple prestrikes and high frequency surges.

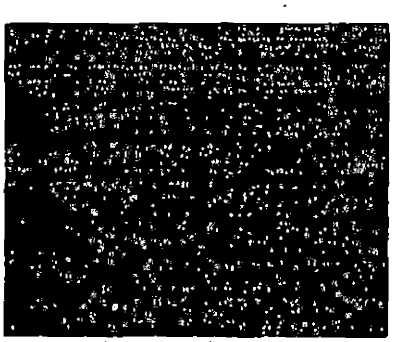


Figure 4D—Line-to-ground voltage across an Arc Furnace Transformer during energization with a vacuum.
ms per major
5 us per major

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a low coil-to-ground capacitance (Figure 7D). When the ratio of the coil-to-coil capacitance to the coil-to-ground capacitance is high—as in the Shell-Form transformer design, the voltage distribution across the coil group with rapidly rising transient voltage is more nearly uniform (Figure 8D). The design of the Shell-Form Furnace Transformer, employing a number of identical

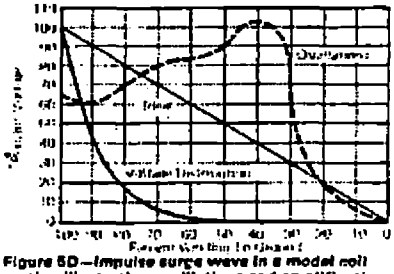


Figure 5D—Impulse surge wave in a model coil section illustrating oscillations and amplification of transient condition.

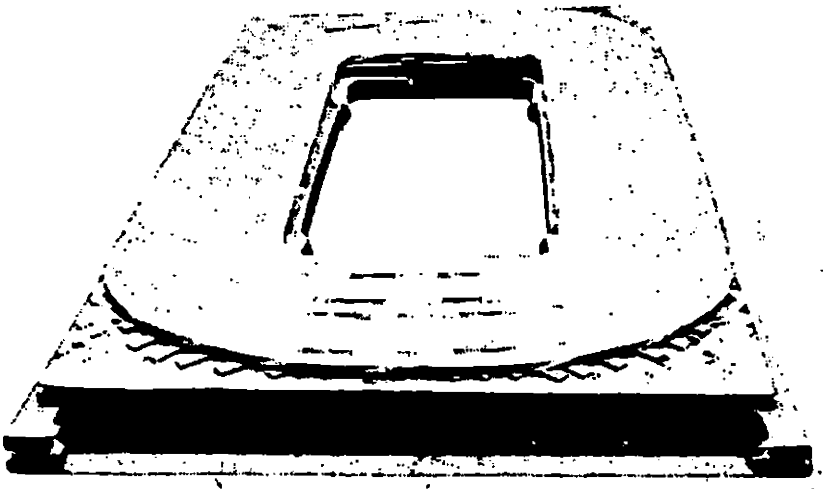


Figure 6D—Portion of a Shell Form HV coil group showing pancake coil.

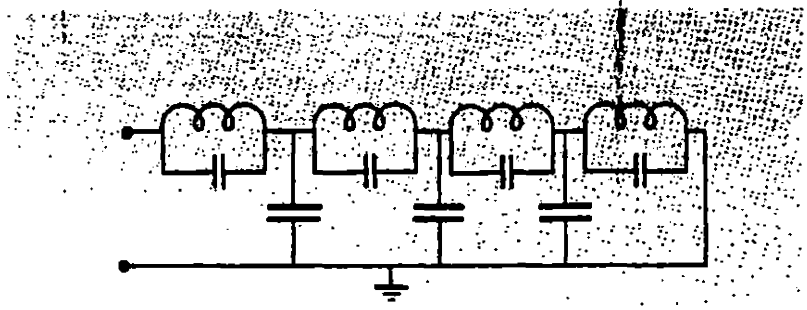


Figure 7D—Equivalent inductance—Capacitance network of a Shell Form winding section.

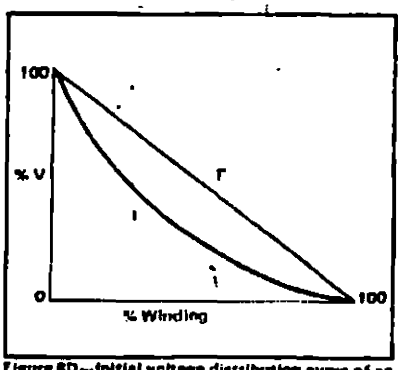


Figure 8D—Initial voltage distribution curve of an impulse surge in a Shell Form winding. F is ideal condition, I actual condition.

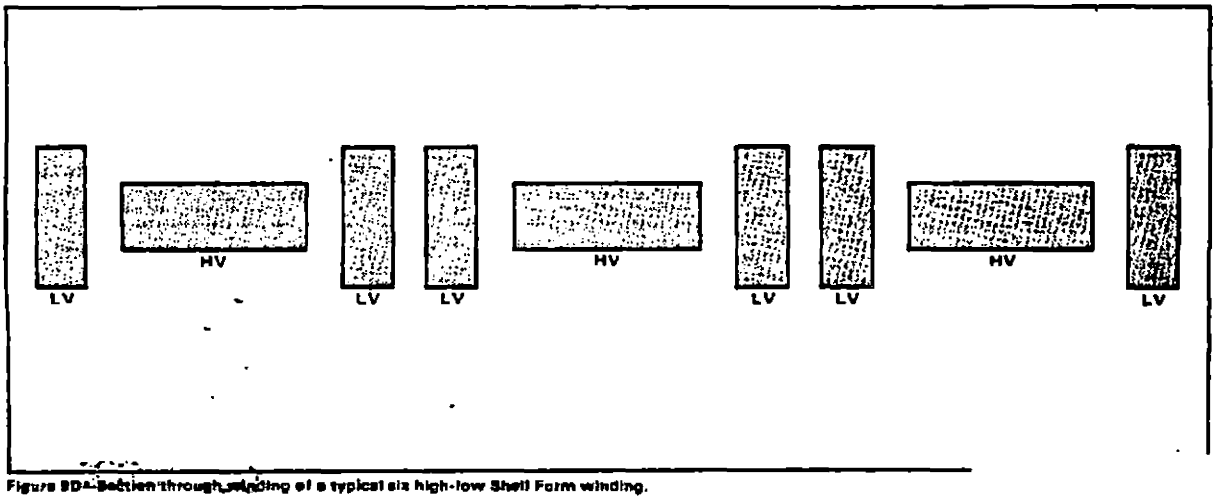


Figure 9D—Section through winding of a typical six high-low Shell Form winding.

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high-low groups and then paralleling of these groups of windings (Figure 9D) further increases the coil-to-coil capacitance and the capacitance ratio, thus magnifying this inherent design advantage.

The turn-to-turn voltage stresses due to the initial application of the transient are thereby reduced in the Shell-Form design insulation system, and the succeeding oscillations developed in the winding are also reduced. The large inherent capacitance of the Shell-Form design causes the natural period of the winding oscillation to be relatively long thus allowing the transient voltages to decay to a low value before the winding oscillations can develop to a significant magnitude.

The insulation structures between coils, between coils and core, and between winding groups are made of high dielectric strength oil impregnated sheets (Figure 10D). Oil spaces are provided with precise relationship to the pressboard structures to control voltage stress concentrations. Special formed insulation pieces are used over the HV coil edges where the voltage stresses are highest. This insulation is utilized in puncture rather than creep for maximum strength.

The HV pancake coils and LV Bus Bar coils are arranged to terminate at the top of the transformer where connections can be made with a short lead (Figure 11D). Mechanical bracing of leads can be readily done and because of the short lead length the magnitude of circulating currents induced by high fields is minimum.

The connections from the LV Bus Bar coils are made by flexible connectors of uniform length (Figure 12D), thus eliminating any impedance unbalance in the bus structure which could cause circulating currents.

The inherent design characteristics of Westinghouse Shell-Form Furnace Transformers assures its reliable operation. The use of auxiliary devices such as preinsertion resistors with the primary vacuum furnace switch has not been necessary with Westinghouse Shell-Form Furnace Transformers.



Figure 12D—View of flexible connectors from LV coil to Bus Bar Bushing in a Shell Form Furnace Transformer.

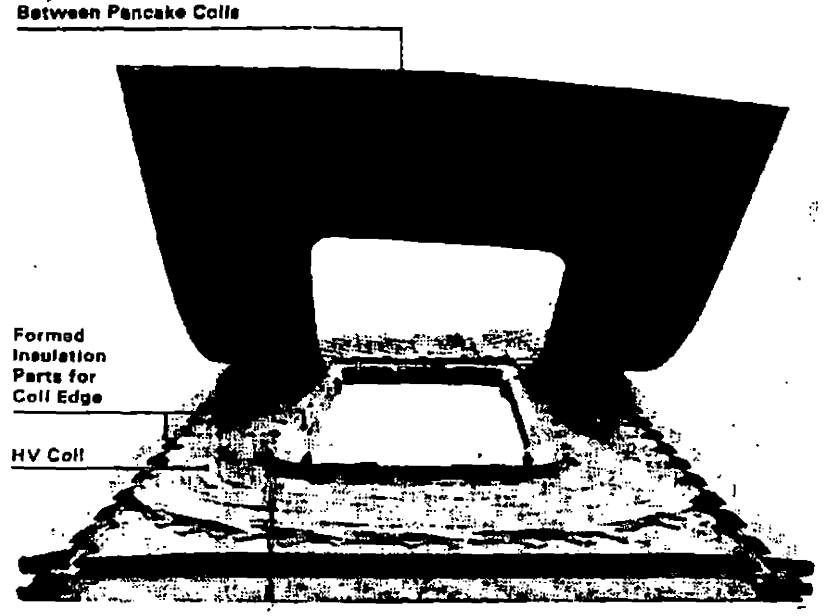


Figure 10D—Portion of a Shell Form HV coil group showing coil and insulation structures.

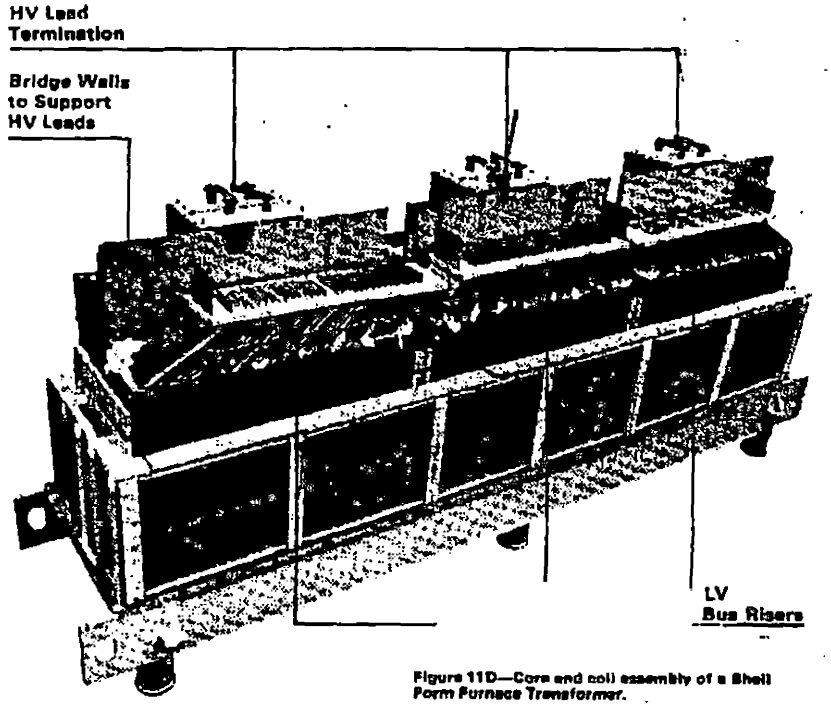


Figure 11D—Core and coil assembly of a Shell Form Furnace Transformer.

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Thermal Capability

Westinghouse Shell Form Furnace Transformers offer significant benefits and advantages in thermal capability:

- Maximum cooling efficiency because of oil flow directly over both sides of the conductor.
- 5-10°C lower hottest spot temperatures.
- As much as 5% increased insulation life because of reduced conductor temperatures.
- Up to 10% greater thermal capability both for continuous loading and short term overload capability.

The transformer is a very efficient device: however, the losses in the electrical circuit and the magnetic circuit generate heat which must be dissipated. The transformer oil in addition to being a liquid insulator serves as a means of carrying the heat away from the working parts of a transformer to a heat exchanger where it can be dissipated. The efficiency of the dispersion system determines the thermal capability and insulation life of a transformer.

Superior thermal capability is inherent in Westinghouse Shell Furnace Transformers, because the HV and LV coils are mounted vertically and pressboard insulation washers with predesigned spacer block pattern are located on either side of the coil providing an ideal path for oil flow over both sides of the conductor surfaces. The core construction is a stack of narrow width silicon steel punchings, thus oil flowing on either side of the core adequately cools this area and oil ducts within the magnetic circuit are not necessary.

The cool oil is forced from the bottom of the tank, traveling over the conductor surfaces picking up heat as it moves to the top of the tank and then out through the heat exchanger, where it cools. The cooled oil re-enters the transformer tank at the bottom (Figure 1T).

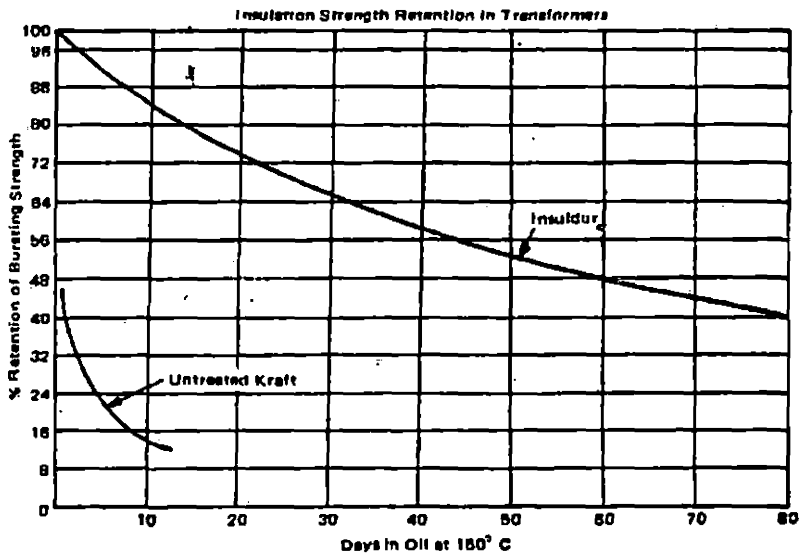
Forced cooling is used on furnace transformers rated above 10,000 KVA to increase their thermal capability and to keep their physical size and weights within practical limits. The forced cooled units (FOW) are designed with a single rating using the pumps to force the oil flow through the coil assembly and out to a water cooled heat exchanger. The forced oil circulation virtually eliminates any oil temperature differential in the transformer tank and substantially lowers coil hot spot temperatures.

Typical temperature characteristics of a FOW Shell Form Furnace Transformer are illustrated in Figure 2T. Assuming an average copper rise of 55°C, the top oil temperature will be approximately 39°C and the bottom oil temperature will approach 33°C. The resulting average oil temperature is then 34°C, and if we adjust the average copper temperature by the 1°C (34°C-33°C=1°C) we arrive at the average top copper temperature of 56°C. A hot spot allowance of 4°C must be applied due to oil flow restrictions and conductor losses resulting in a hottest spot temperature of approximately 60°C.

Wemco "C" Insulating Oil. 55822-AG (2772)

Wemco "C" insulating oil is a refined mineral oil obtained from the fractional distillation of crude petroleum. It contains no moisture, inorganic acid, alkali, free sulphur, asphalt, tar, vegetable or animal oils. It is used as an insulating and heat transfer medium providing a natural and efficient method of transferring the heat from the electrical elements to the tank walls, radiators or other heat exchanger.

Insuldur Insulation System



The introduction of the Westinghouse Insuldur insulation system was a very significant development in the transformer industry. The Insuldur treatment is a means of thermally upgrading cellulose insulating materials and results in 12% higher load ability when the transformer is operated at 65°C average winding rise.

The Insuldur treatment stabilizes the cellulose material against oxidation, dehydration and hydrolysis thus enabling the transformer to operate at the higher temperatures without sacrificing life expectancy.

Thermal Capability

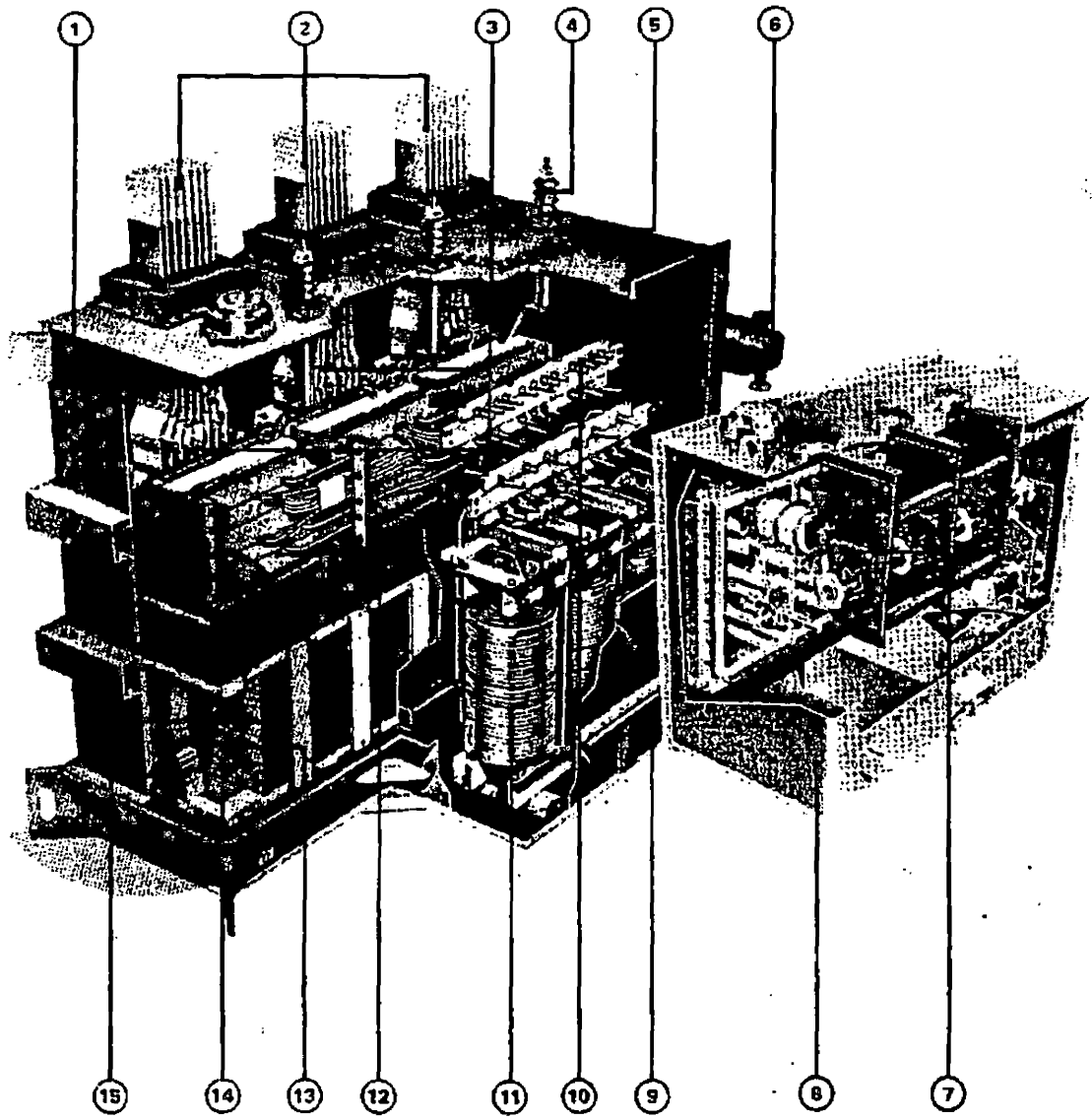


Figure 17

Arc Furnace Transformer with UVT Load Tap Changer

(1) Form Fit Tank Top Section
(2) LV Bus Bar Bushings
(3) LV Flexible Connectors
(4) HV Bushing
(5) Inspection Covers
(6) FOW Cooler
(7) Tap Changer Interrupter Mechanism
(8) Tap Changer Compartment
(9) Tank Base
(10) HV Tap Changer Leads
(11) Preventive Autotransformer
(12) Bridge Structure
(13) Coil
(14) Insulation Washer
(15) Core

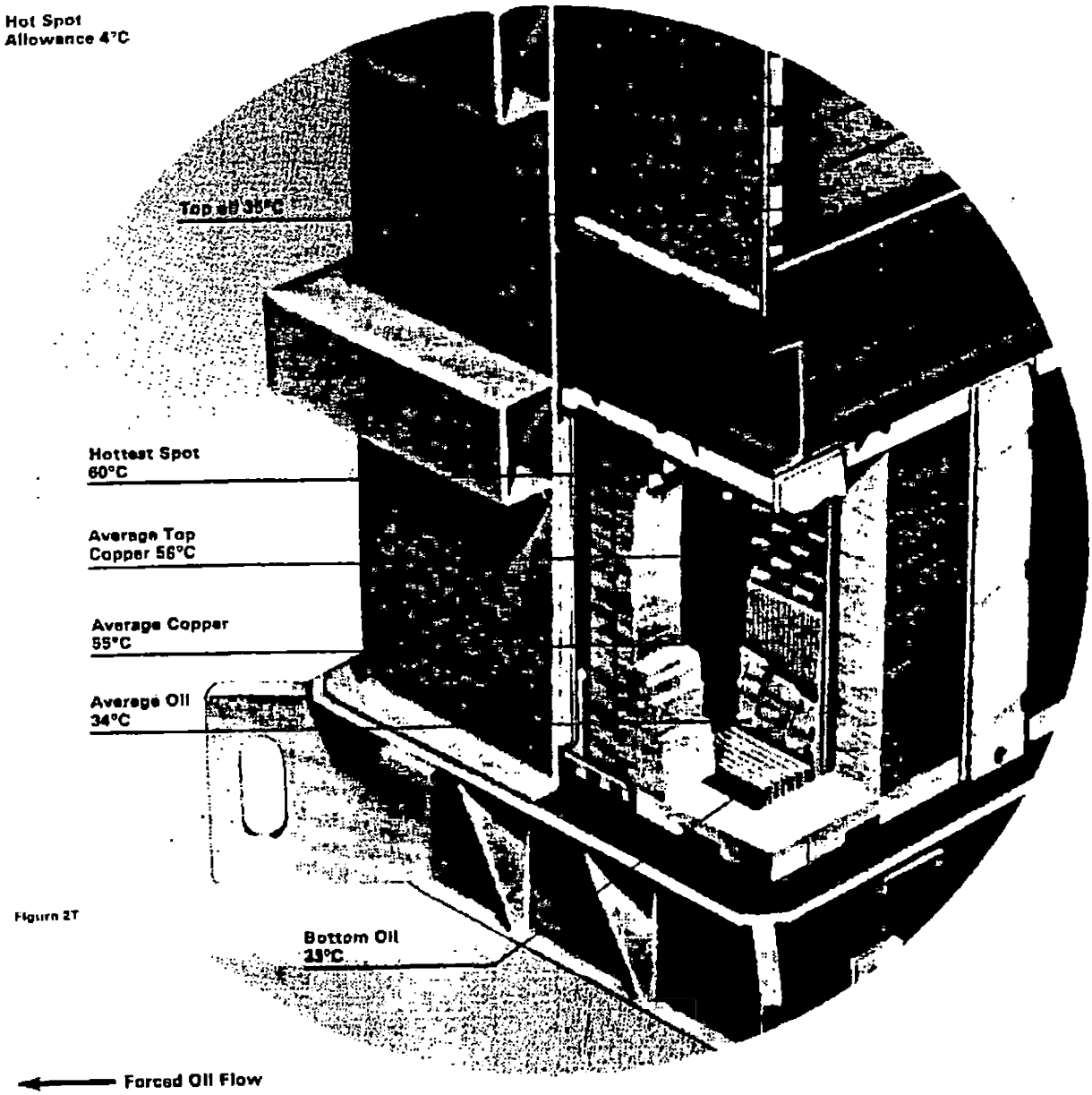

Hot Spot
Allowance 4°C
Top oil 35°C
Hottest Spot
60°C
Average Top
Copper 56°C
Average Copper
55°C
Average Oil
34°C
Bottom Oil
23°C
Forced Oil Flow

Figure 27

Testing

Indisputable proof of the reliability of a transformer and confirmation of its performance characteristics is established by tests. All Westinghouse shell form furnace transformers are tested in accordance with American National Standards Institute Test Code for Transformers.

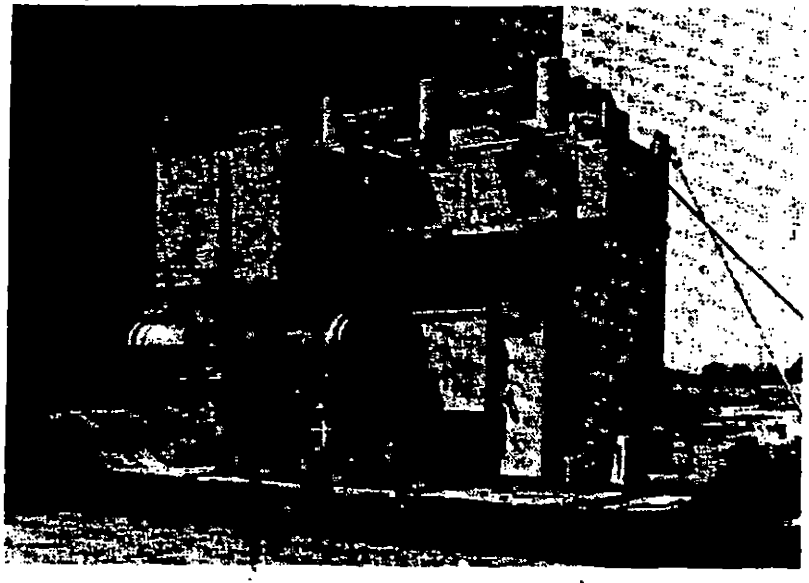
Standard Tests applied to all units:

- Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on an order.
- Ratio, Polarity and Phase-relation tests on the rated voltage connection and Ratio tests on all tap voltages.
- No load loss at rated voltage connection.
- Exciting current at rated voltage on the rated voltage connection.
- Impedance and load loss at rated current on the rated voltage connection of each unit and on the top extremes of one unit only of a given rating of an order.
- ANSI Temperature Test. Temperature test will be made on one unit only of an order covering one or more units of a given rating. Tests will be made only when there is not available a record of a temperature test on a duplicate or essentially duplicate transformer.
- Applied Potential Test.
- Induced Potential Test.

Tests which will be performed at purchaser's option and at additional cost:

- ANSI Impulse Tests.

Shipping Procedures



Westinghouse Shell Form Furnace Transformers are shipped on depressed center rail cars. In almost all cases the transformers are shipped with oil in the tank and with all accessory items installed. Items which could be damaged in shipment, such as arresters and surge capacitors, are removed from the unit and packed separately for shipment.

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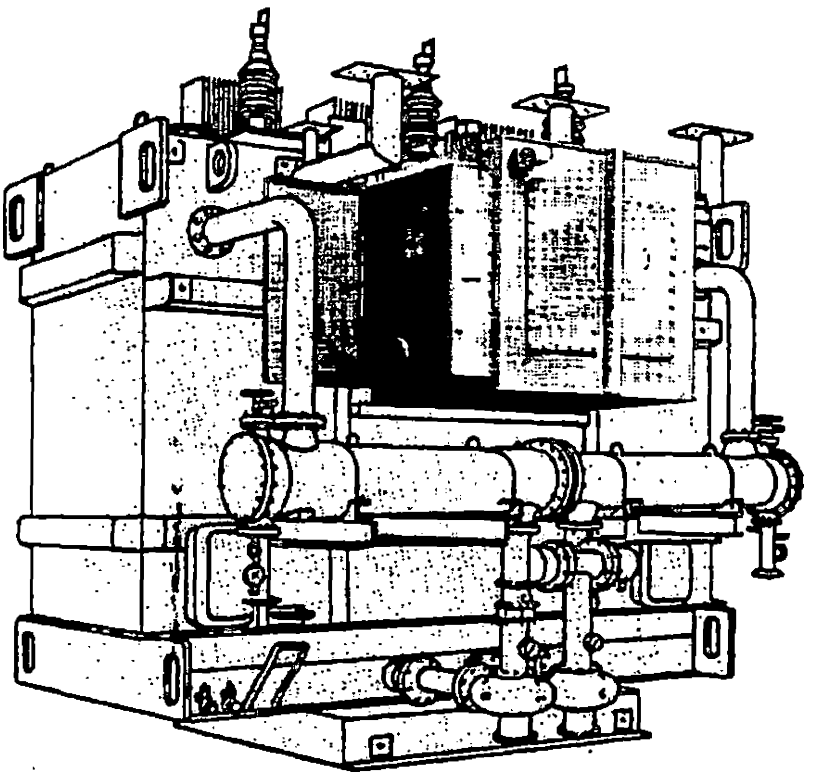
Motor Operated No Load Tap Changer and Delta/WYE Switch

The Westinghouse Motor Operated No Load Tap Changer and Delta/Wye Switch provide voltage regulation of the furnace transformer low voltage by tapping out turns in the HV winding. The voltage regulation range is doubled by switching the HV winding from a Delta to a Wye connection by means of the Delta/Wye Switch. The standard tap changer has either six or eight available tap positions.

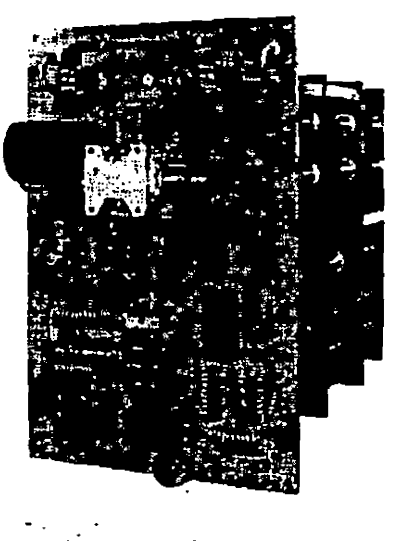
The Tap Changer and Delta/Wye Switch are located in a separate compartment mounted on the main transformer tank. Connections from the transformer winding to the switching mechanism are made through an oil-tight terminal board.

The motor and control mechanism are assembled into a weatherproof compartment which is mounted on the end of the tap changer compartment. A single motor drive operates both the Tap Changer and Delta/Wye Switch.

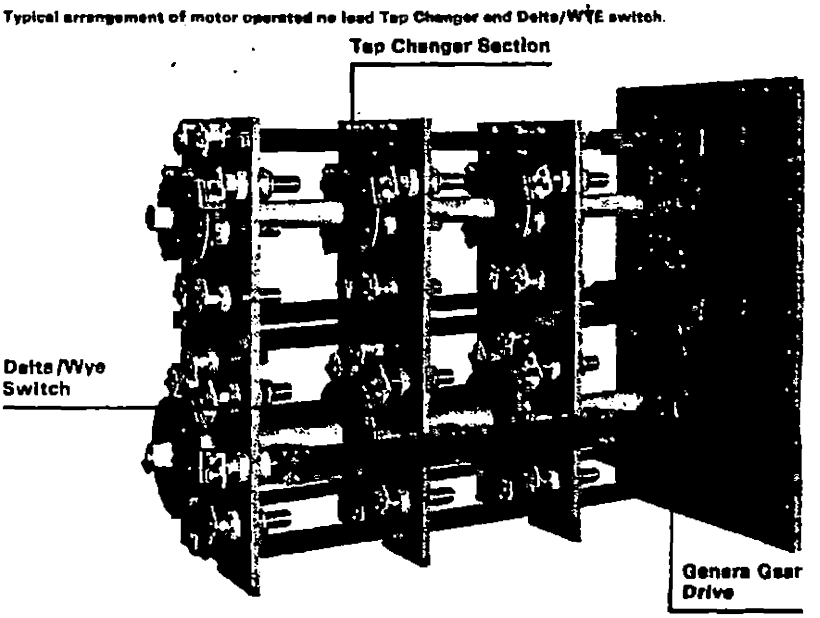
The number of tap positions and the winding connection on each position is set at the time the transformer is designed. However, considerable versatility is possible on the voltages available to the furnace operator. Within the limits of the available taps, the number of positions and the voltages available at the furnace control may be preselected by changing the setting of the multideck-tap position switch in the control cabinet.



Typical arrangement of motor operated no load Tap Changer and Delta/WYE switch.

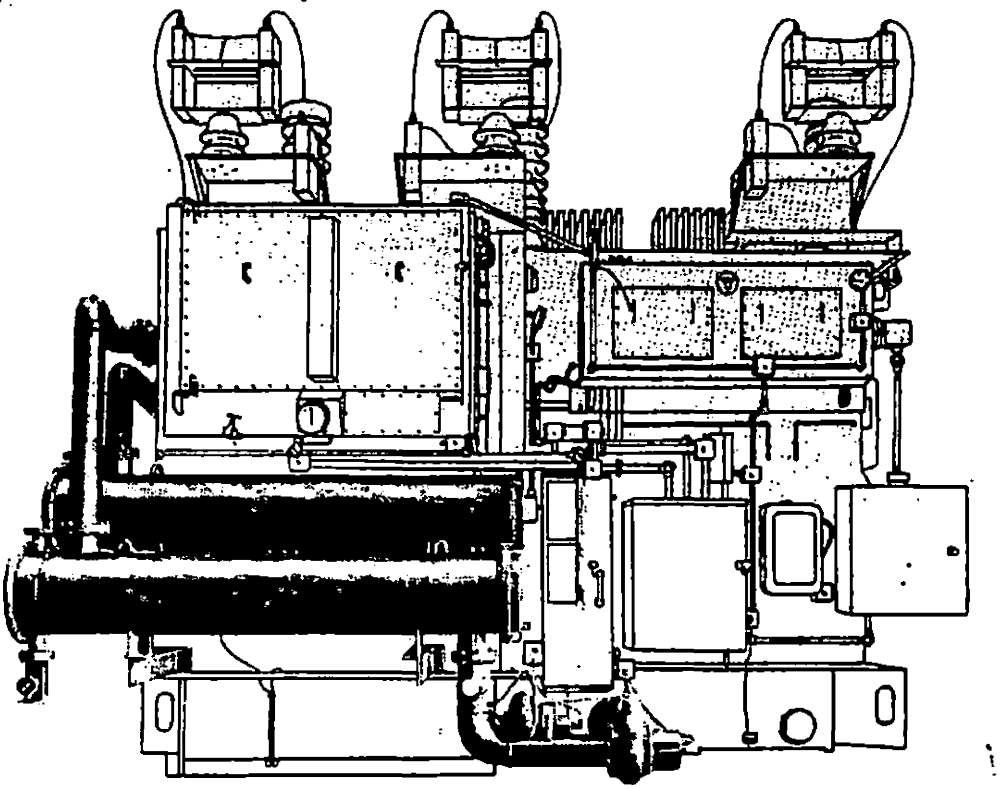


Motor and Control Mechanism.



Internal assembly showing switches and gear drive.

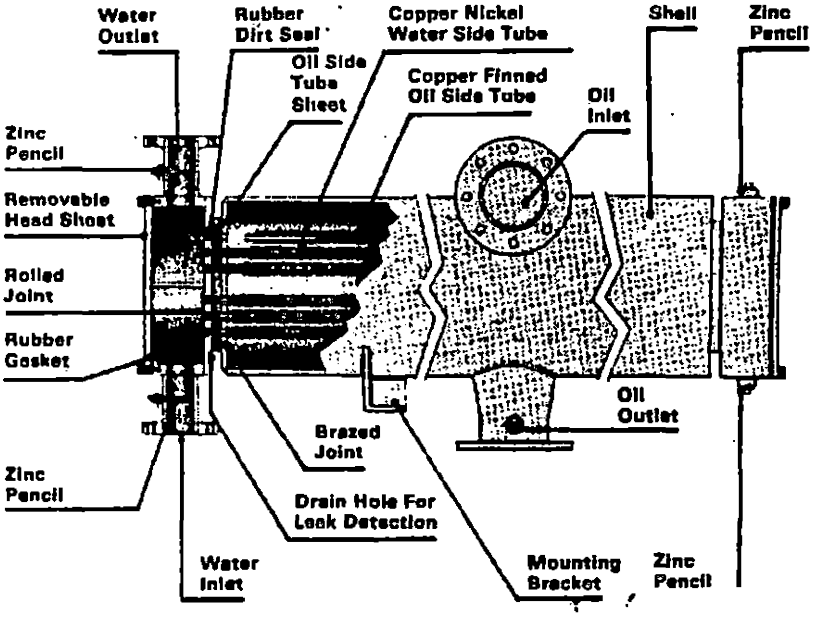
Doubleguard Oil To Water Heat Exchanger



This Westinghouse heat exchanger is an efficient and compact method of cooling types OW, OW/FOW or FOW transformers. It uses double concentric tube construction. The internal (waterside) tube is made of 90-10 cupronickel, making use of saline or raw river water feasible. The outer (oilside) tube is copper with extruded copper fins to provide better heat transfer. Straight tubes promote ease of cleaning.

The water boxes on either end are separated from the oil shell by two head sheets which, have an air space between them. The inside diameter of the outer tube is fluted to provide space for liquid to flow to the outside should a leak occur in either tube. This makes a leak from one fluid to the other virtually impossible and provides a means for visual inspection.

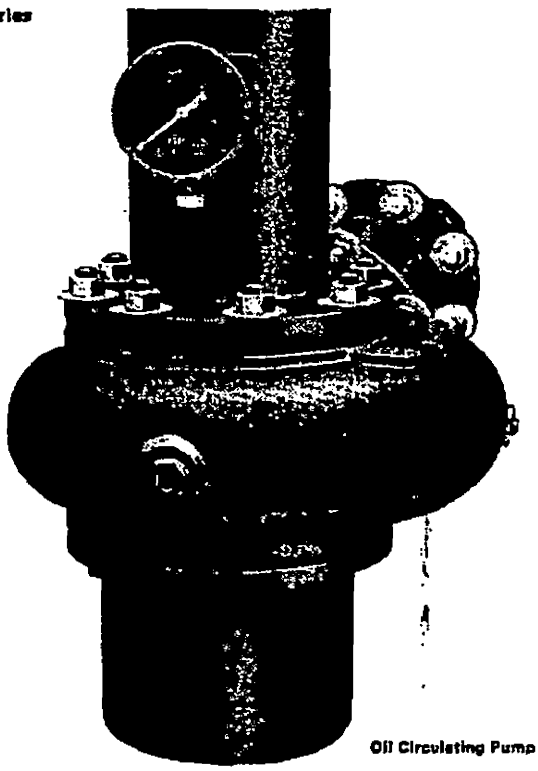
Both the oil shell and waterboxes are of welded steel construction except for a bolted waterbox cover to permit tube cleaning.



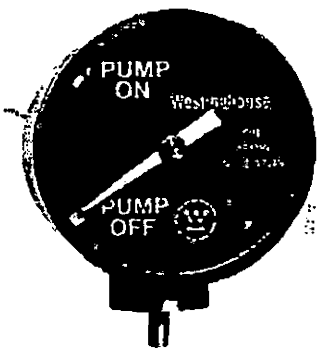
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770351

Thermal Accessories



Oil Circulating Pump



Oil Flow Indicator



Oil Circulating Pumps

The circulating pumps supplied on Westinghouse forced-cooled power transformers are a special centrifugal design using a close coupled pump and motor enclosed in a cast iron housing. The oil flow within the pump is directed to provide bearing lubrication and cooling for the motor stator.

The pump is suitable for multiple mounting positions and can be applied to all types of Westinghouse coolers or radiators.

Oil Flow Indicator

The Westinghouse oil flow indicator is a vane operated instrument designed for use with each forced oil pump on a transformer. It provides visual indication and confirmation by electrical alarm switches, of the proper operation of the pump and adequate oil flow for cooling.

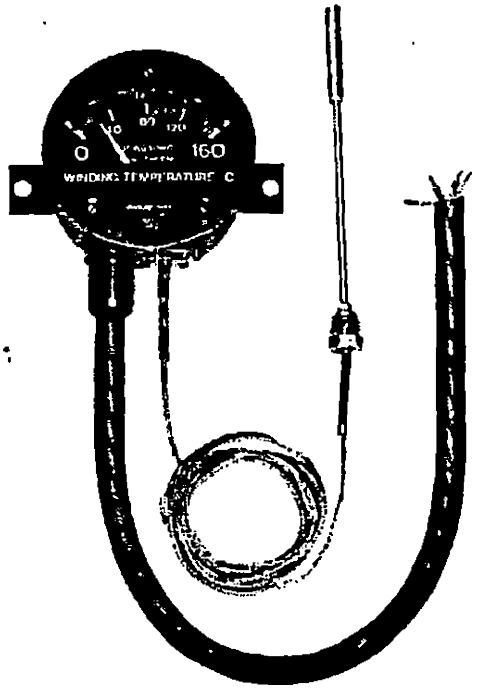
The alarm switch leads are brought out through a threaded receptacle for connection to remote alarm equipment.

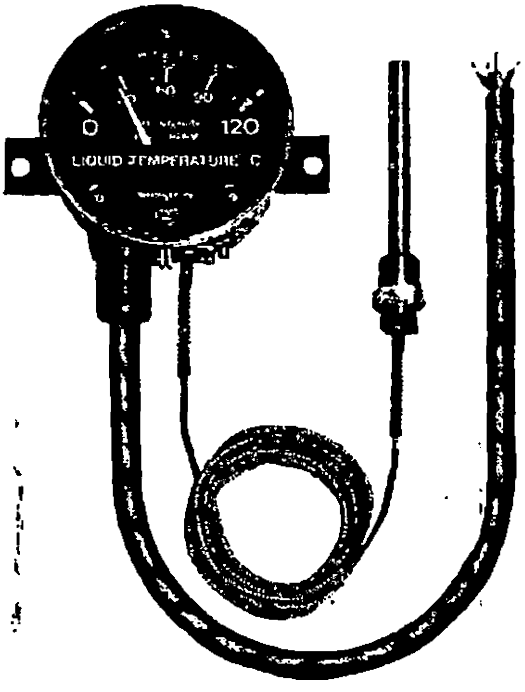
Liquid Level Indicator

The liquid level indicator designed for Westinghouse transformers is a self-contained float operated instrument. The indicator is a two part assembly..The sealed body is attached to the tank wall and contains an actuating magnet shaft connected to the float arm inside the transformer. The bezel, or outer assembly, contains the calibrated dial and indicating needle. The indicating needle is directly connected to a second magnet which is positively displaced by the rotation of the magnet and float arm assembly in the sealed body. Alarm switches are enclosed in the bezel and alarm leads are terminated in a threaded receptacle from which they can be connected to remote equipment. No oil leaks can occur around the instrument because of the sealed body design.



Liquid Level Indicator





Winding Temperature Indicator

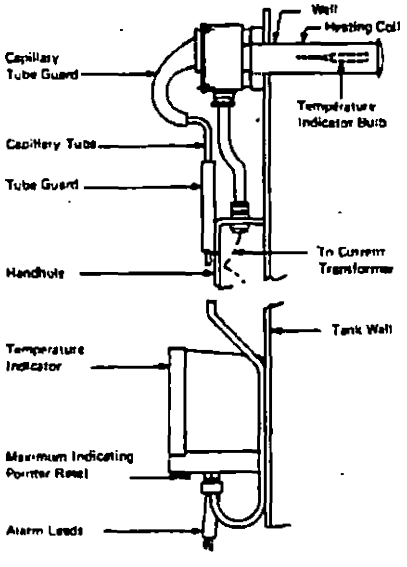
The Westinghouse hottest spot temperature indicator is an assembly utilizing a bourdon gauge, calibrated in degrees centigrade, connected to a bulb by a capillary tube. The indicator is located on the tank wall at eye level for convenient reading. The thermometer bulb and a heating coil are assembled in a well located in the hottest oil near the top of the transformer.

Current, proportional to the transformer load current, is supplied to the heating coil by a current transformer. This adds an increment of temperature to the thermometer bulb which is equal to the winding hot spot rise above hot oil temperature. Thus, the instrument indicates hot spot temperature.

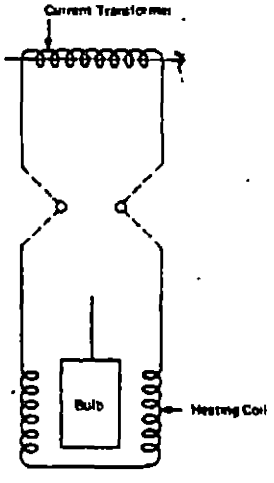
Three switches are provided in the instrument to operate forced-cooling control and alarm circuits.

Liquid Temperature Indicator

The liquid temperature indicator is mounted on the transformer tank at eye level. The assembly utilizes a bourdon gauge connected to a thermometer bulb by a capillary tube. The thermometer bulb is enclosed in a well located in the hottest oil near the top of the tank. Two switches are provided in the instrument for operation of auxiliary and alarm circuits.

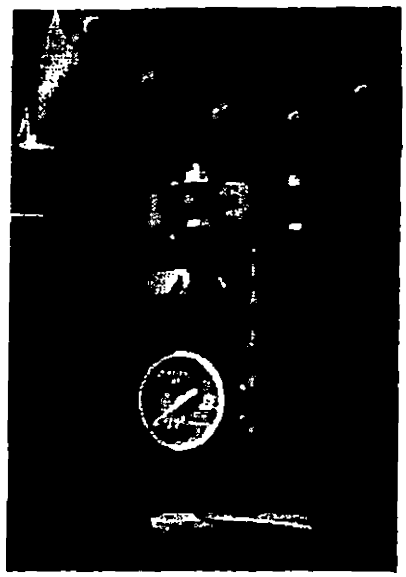


Sectional View of Transformer Showing Mounting of Indicator with Flexible Tube



Connection Diagram for Current Transformer and Heating Coil

Water Flow Indicator



The Westinghouse Water Flow Indicator is a vane operated instrument designed for use with the FOW cooler. The instrument is located in the water inlet of the cooler. It provides visual indication and confirmation by electric alarm switches, of the adequate flow of cooling water.

The alarm switch leads are brought out through a threaded receptacle for connection to remote alarm equipment.

Standard Paint Finish

The paint finish on a transformer serves two purposes—to protect the exposed metal surfaces from corrosion and to enhance the appearance of the unit.

Several steps are followed in painting a Westinghouse transformer and its accessories:

The steel plate used to fabricate the tank is thoroughly cleaned of mill scale and corrosion by rotary blasting equipment.

The complete tank is shotblasted for removal of weld spatter and other surface dirt accumulated during fabrication.

The tank is then painted using an "Airless Spray" process. A primer coat of alkyd vehicle and rust inhibitive pigment is applied followed by a finish coat of alkyd vehicle and pigments. Both coats of paint are air dried to assure proper curing and adhesion to the metal surfaces.

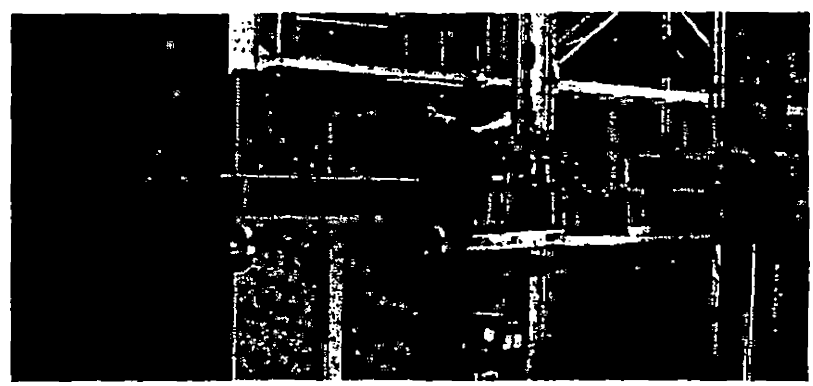
A final touch-up coat of alkyd vehicle and pigments is applied to the completed transformer immediately prior to shipment.

Accessory items are painted separately using a similar process.

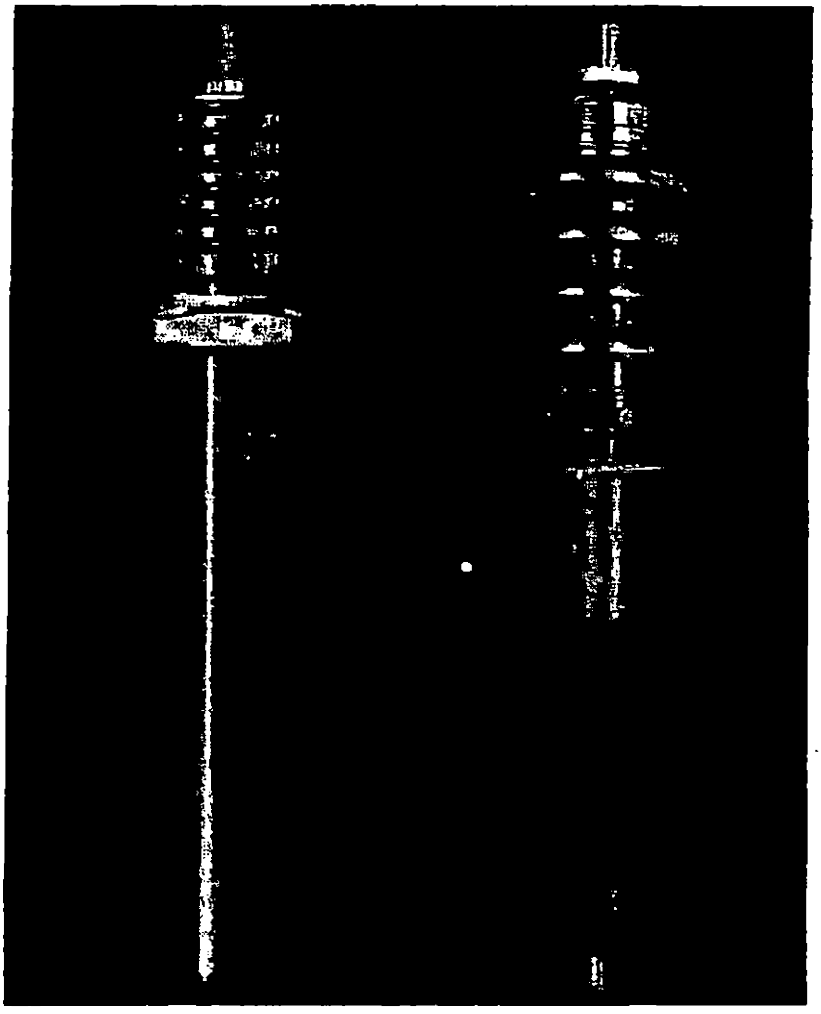
The standard color for Westinghouse furnace transformers is ANSI 70 Light Grey. ANSI 24 Dark Grey is available at no additional cost. Nonstandard colors are also available at additional cost providing the material is compatible with Westinghouse primer.



Completed Tank in Shotblast Room for Touch-up Cleaning



Application of Paint



HV Bushings

Several designs of bushings are used for the HV terminals of Westinghouse Shell Form Furnace Transformers, depending on the BIL and current requirements. All designs comply with industry standards pertaining to electrical and mechanical characteristics.

RJ Bushings

RJ Bushings are applied on transformer windings 15 KV and below. This bushing uses a lead encased in a single piece wet process porcelain. A forged aluminum flange is rolled into a groove on the porcelain over a silicone rubber gasket to form an integral assembly.

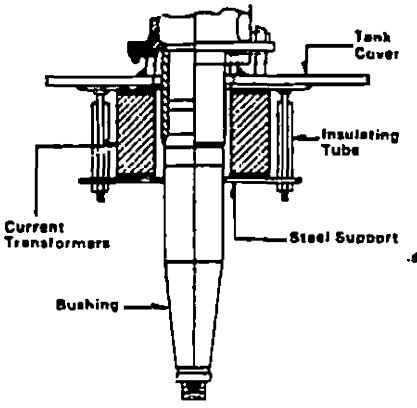
OS Bushings

This bushing is applied to transformers with HV windings through 46 KV-250 KV BIL. The condenser is wound on the conductor tube using treated kraft paper. Metal foil is inserted at appropriate diameters to form the condenser. A porcelain weather shield is solder sealed to the conductor tube and flange to protect the external portion of the condenser. The space between the condenser and weather shield is filled with Wemco C oil.

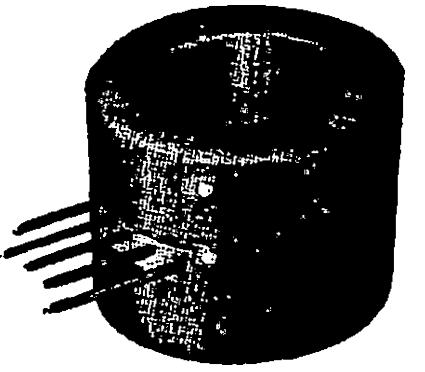
Multi-Ratio Bushing Type Current Transformers

Ampere Rating Range 600/5 to 5000/5.
60 Hertz

Multi-ratio current transformers are used as a current source for relays and indicating instruments. The current transformers are supported by brackets on the tank cover and utilize the bushing lead as a single turn primary. Other mounting configurations such as the internal transformer bus work or the external portion of the bushing are also used. The tap ratios, current ratings and accuracy conform to ANSI Standards. Taps for multi-ratio ratings are available through 5000 amperes; ratings above 5000 amperes are generally single ratio.



Typical BCT Mounting

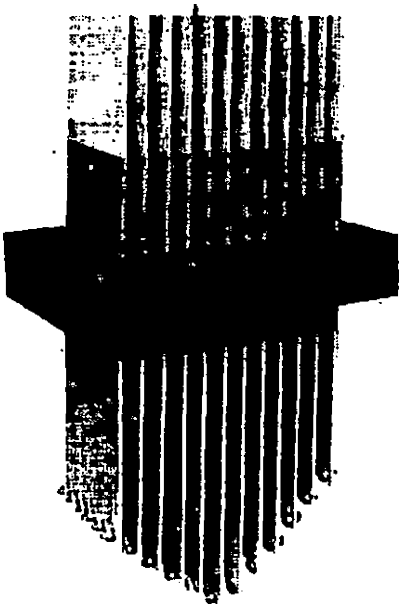


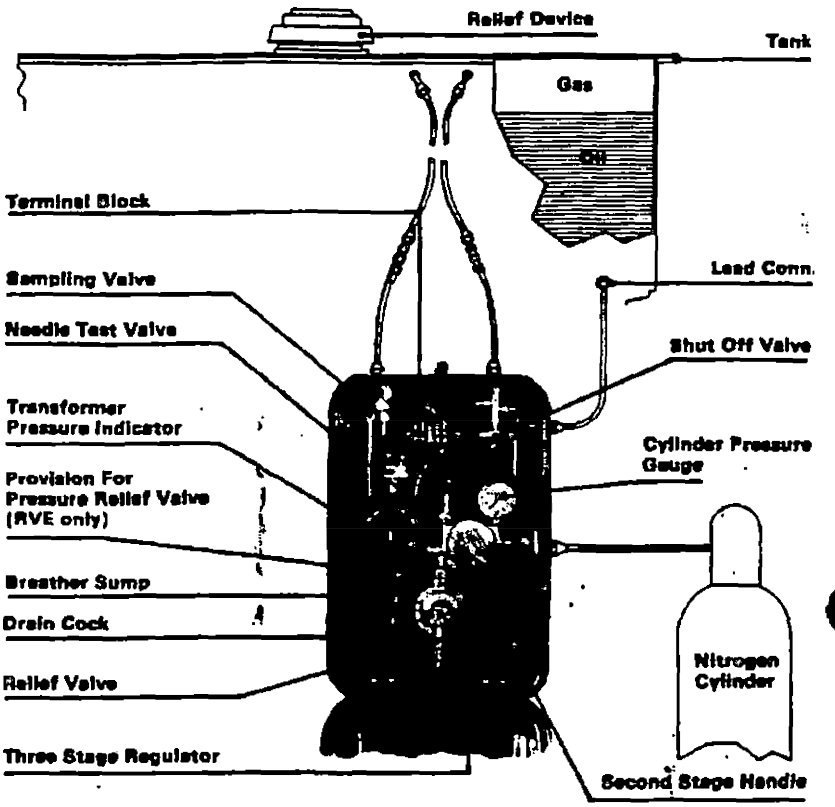
Low Voltage Bus Bar Bushing

The low voltage windings of a Westinghouse Shell Form Furnace Transformer are terminated and brought through the cover in a Bus Bar Bushing. The bus bar assembly is cast into a block of especially prepared resin, having the same coefficient of expansion as copper, thus eliminating the possibility of cracking due to thermal cycling.

Vertical creep distance is attained by painting the sides of the bars and the surface of the resin block with an epoxy paint. The paint provides a smooth glossy surface which prevents the adhesion of dirt.

The bushing assembly will withstand full vacuum and pressure up to 10 PSI, thus preventing moisture and foreign material from entering the transformer tank.





Inertaire® Equipment—Type RBE

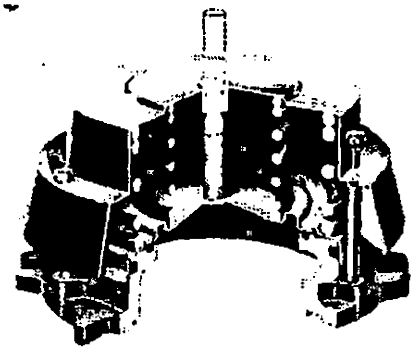
Westinghouse Inertaire equipment assures *long transformer life and negligible oil deterioration* by maintaining a cushion of dry nitrogen above the oil of the transformer. The nitrogen is supplied from a steel cylinder and is automatically fed into the transformer through a reducing valve whenever the internal pressure in the tank falls below ½ pound per square inch.

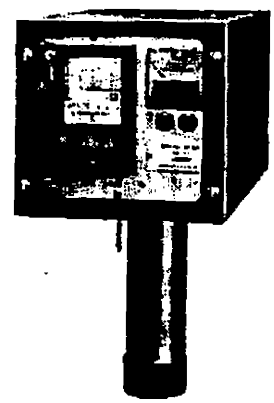
A relief valve incorporated into the controls conserves nitrogen in the gas space by permitting it to escape into the atmosphere only when the pressure in the transformer reaches a predetermined value.

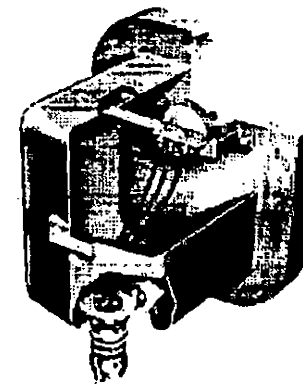
A sampling valve connected to the gas space provides a means of sampling the gas for oxygen content. A compound pressure gauge indicates internal tank pressure or vacuum.

All equipment except the nitrogen cylinder is enclosed in a weatherproof cabinet with padlocking provisions.

NPC00007718







Automatic Resetting Relief Device

The Automatic Resetting Relief Device used on Westinghouse transformers is designed to relieve dangerous pressure which may build up within the transformer tank. When a predetermined pressure is exceeded, the reaction lifts the diaphragm of the relief device and vents the transformer tank.

The design features a dome-shape diaphragm, compression springs, gaskets and a protective cover. A lightweight plastic semaphore is used to indicate an operation of the relay. An alarm switch with contacts is available for remote signal of an operation. The compression springs reset the diaphragm on the gaskets following an operation thus preventing the entry of foreign material into the transformer tank.

Combustible Limit Relay CLR-1

The Combustible Limit Relay automatically tests the combustibility of the gas in a power transformer. The relay is specifically designed for application on transformers equipped with Inertaire Oil Preservation System, and will actuate an alarm circuit if the combustible gas content over the surface of the oil reaches a predetermined level.

Many types of incipient faults produce combustible gases as breakdown products of oil or organic insulating materials in a transformer. Periodic testing of the nitrogen atmosphere over the oil will reveal the presence of combustible gases and serve as a warning of impending problems.

The relay contains an electrical timer and a solenoid valve, which controls the flow of the sample to an aspirator. The aspirator blends air with the sample to insure oxidation of any combustible gas that may be present. The blend of air and gas sample are passed into a gas reaction chamber where any combustibles are ignited by a heated filament. The filament is connected as one leg of a bridge circuit and the additional heat from the combustion of the gas sample raises the temperature of the filament, changes the resistance and unbalances the bridge circuit. The meter indication in the bridge circuit is proportional to the degree of unbalance and the percentage of combustibles in the sample.

A recorder is available for application in the relay circuit to provide a record of periodic sampling. The relay and the recorder are optional accessories and can be purchased with the transformer or added in the field to installed transformers.

Sudden Pressure Relay

The Westinghouse Sudden Pressure Relay is designed to respond to sudden increases in internal gas pressure in a power transformer. Normally, such pressure increases are caused by an internal arc and the associated circuitry of the relay can be arranged to initiate alarm and trip circuits, to de-energize the transformer. Damage to the transformer can be minimized in this way.

The relay consists of a pressure sensing bellows, an alarm switch, and a pressure equalizing orifice all enclosed in a sealed case. The relay is specifically designed for application with the Inertaire Oil Preservation System. It is mounted at the top of the transformer, at the gas space.

A seal-in relay, reset switch and other associated circuitry are mounted on a panel in the transformer control cabinet. A Voltrap® surge suppressor is connected across the trip contacts at the seal-in relay to prevent extraneous induced voltages in the alarm circuits from causing false operations. The relay is not affected by external mechanical shock or vibration.

Westinghouse Electric Corporation
Large Power Transformer Division
Muncie, Indiana 47305 USA

Printed in USA

INSTRUCTIONS FOR CAPACITOR UNITS

Capacitor Units are designed for use in electrical power systems to improve power factor. They are intended to be mounted, individually or in groups in open racks, and require no additional protection from the weather under ordinary service conditions.

RECEIVING

When unpacked, carefully inspect the unit for damage and check the nameplate to be sure that the desired rating has been received. File a claim immediately with the carrier for any damages sustained in transit and obtain a carrier inspection report.

INSTALLATION

CAPACITOR RATINGS. Many capacitors are available, including those listed in NEMA Standards; and all meet the requirements of these standards.

The maximum continuous operating voltage is 110 percent of the nameplate rating.

WHEN INSTALLING CAPACITORS, CHECK THE NAMEPLATE OF EACH UNIT TO SEE THAT IS HAS THE PROPER RATING FOR THE CIRCUIT.

MOUNTING CAPACITORS. Standard hanger brackets for one or more units are available and are furnished as a separate item when ordered. When mounted otherwise than in standard hangers, care should be used to obtain the necessary spacing and clearances.

NPC00007721

The parallel groove connectors will accommodate any combination of two conductors from #12 solid to #1 stranded wire. Terminals should be tightened firmly, but avoid excessive force.

TORQUES OF MORE THAN 20 FOOT POUNDS ARE NOT NECESSARY OR RECOMMENDED.

THE MINIMUM SPACING BETWEEN LARGE SIDES OF ADJACENT UNITS SHOULD NEVER BE LESS THAN THAT RECOMMENDED BY WESTINGHOUSE.

FUSING. A capacitor installation should be fused to remove the equipment from the line in case of a faulty unit. (Fuses are not normally applied for overload protection.)

The fuse must have enough thermal capacity to prevent blowing on line surges and charging current. It should also be able to clear the fault quickly to avoid rupture of the capacitor case and consequent damage to other units or equipment.

LIGHTNING ARRESTERS AND GROUNDING. The capacitor installation should be protected by distribution type lightning arresters mounted on the same pole as the capacitors connected to a good ground at the base of the pole.

The capacitor unit hangers should be grounded by a solid connection to the lightning arrester ground terminal.

MAINTENANCE

The capacitor should be inspected periodically after being placed in operation to be sure that it continues to operate properly. A slight bulge is common and should not be mistaken for a failure. Failed units are not always visibly detectable. Heat loss in the capacitor is dissipated by both convection and radiation. Therefore under normal operation the capacitor will be warm. If a capacitor unit develops a minor leak (no more than a few drops) contact the nearest Westinghouse office regarding the possibility of repair.

FIELD TESTS

The insulation of a capacitor unit may be checked by applying 110 percent of the rated voltage between terminals or from terminals to case from a suitable protected source. For terminal-to-terminal tests, the Kva output of the source must be at least as great as the capacitor Kvac rating.

The capacitor may be checked for open circuits or short circuits by applying a low voltage, such as 110 volts from a fused source, and measuring the current. The current drawn by the capacitor should be in proportion to the applied voltage; for example, a 2400 volt unit should draw 110/2400 times rated current if tested on 110 volts and rated frequency.

For more detailed field test procedures, see NEMA CP1.

Over-voltage tests on new units are permissible under certain conditions but are seldom advisable. Advice on allowable voltages and test equipment should be obtained from the factory before this is attempted.

CAUTION

ALLOW FIVE MINUTES AFTER DISCONNECTING TO PERMIT THE CAPACITOR TO DRAIN THROUGH THE INTERNAL DISCHARGE RESISTOR. THEN FOR SAFETY, SHORT CIRCUIT THE TERMINALS BEFORE HANDLING.

DISPOSAL

THIS PRODUCT CONTAINS A POLYCHLORINATED BIPHENYL (PCB). TO AVOID POSSIBLE ENVIRONMENTAL CONTAMINATION, IT SHOULD BE DISPOSED OF ONLY IN SUPERVISED DRY LANDFILL AREAS MEETING STATE REQUIREMENTS OR IN INCINERATION FACILITIES DESIGNED FOR DISPOSAL OF PCB'S. SEE AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINE NO. C107.1-1974 (OR LATEST REVISION) FOR FURTHER INFORMATION. COPIES ARE AVAILABLE FROM AMERICAN NATIONAL STANDARDS INSTITUTE, 1430 BROADWAY, NEW YORK, NEW YORK 10018.

TRANSPORTATION TO THE DISPOSAL FACILITIES SHOULD BE IN CONTAINERS THAT WILL PREVENT LEAKAGE AND ACCIDENTAL LOSS OF ASKAREL TO THE ENVIRONMENT. CONTAINERS SHOULD BE LABELED AS TO THE CONTENTS AND PRECAUTIONS RELATIVE TO LOSS TO THE ENVIRONMENT.

WESTINGHOUSE ELECTRIC CORPORATION

Distribution Apparatus Division
Bloomington, Indiana 47401

NPC00007724

cc- Burch - K Kelly
A.J. FINK

american national standards institute, inc.

Secretary:
National Electrical Manufacturers Association
821 Fifteenth St., N.W.,
Washington, D.C., 20005 (202) 347-4848

March 23, 1976

TO: ALL REPRESENTATIVES OF MEMBER COMPANIES IN NEMA'S TRANSFORMER SECTION, AND ALL MEMBERS OF THE TRANSFORMER SECTION'S TECHNICAL COMMITTEES;

ALL REPRESENTATIVES OF MEMBER COMPANIES IN NEMA'S CAPACITOR SECTION, AND ALL MEMBERS OF THE CAPACITOR SECTION'S TECHNICAL COMMITTEE;

ALL MEMBERS OF ANSI C107 COMMITTEE ON ASKARELS;

ALL MEMBERS OF THE NEMA TRANSFORMER INDUSTRY/EPA WORKING GROUP

Subject: PCB Treatment or Disposal Facilities

Gentlemen:

Enclosed is a list of treatment and/or disposal facilities for PCBs which was prepared by the Environmental Protection Agency (EPA). EPA has asked that we circulate this to you for your information.

Sincerely,

C. R. Willmore

C. R. Willmore
Secretary, ANSI C107

CRW:pmk
Encl.

cc: J. H. Motherway
C. A. Parris

Ref - for customers who ask Donald Clair

NPC00007725

770364

PCB TREATMENT OR DISPOSAL FACILITIES

The firms listed below (not all-inclusive) will accept PCBs for treatment or disposal, as noted. The Environmental Protection Agency does not endorse any of these firms and cannot vouch for the enviromental adequacy of their operations. Each of these firms has been contacted and reports having the required technical characteristics to adequately handle PCBs, in accordance with Recommended Procedures for the Disposal of PCB-Containing Waste (Industrial Facilities) as published by EPA in the Federal Register. The appropriate State or EPA Regional Office should be consulted for environmental suitability of the firm/site.

1. California Class I Landfills

(a) Casmalia Disposal Site
Santa Barbara, California (805-969-4703)
Bulk liquids and drummed materials.

(b) BKK Corporation
Wilmington, California (213-775-3607)
All forms.

(c) Environmental Protection Corporation
Bakersfield, California
All forms.

(d) County of Los Angeles
Whittier, California (213-699-7411)
Facilities: Palos Verdes
Calabasas
All forms.

(e) Richmond Sanitary Service
Richmond, California (415-234-3304)
All forms.

(f) San Diego County
San Diego, California (714-565-5703)
All forms.

(g) Ventura County Dept. of Public Works
Ventura, California (805-648-2717)
All forms.

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2. Chemical Waste Disposal Co.
Elizabeth, N.J. (201-351-5460)
Disposal by incineration

3. Chem-Trol Pollution Services, Inc.
Model City, N.Y. (716-754-8231)
Can handle solids and liquids by incineration or land disposal.

4. General Electric Corp.
Pittsfield, Mass. (413-494-3729)
Can handle only liquids and complete transformers. Liquids are incinerated.

5. Hyon Waste Management Services, Inc.
Chicago, Ill. (312-646-0016)
Can handle solids and liquids by incineration

6. Monsanto Company.
St. Louis, Mo. (800-325-3850)
Handles only liquid askarels manufactured by Monsanto
Disposal is by incineration.

7. Nuclear Engineering Co., Inc.
Louisville, Ky. (502-426-7160)
Facilities: Sheffield, Ill.
Beatty, Nev.
Disposal by landfill. Can handle drummed liquids and solids.

8. Rollins Environmental Services
Main Office: Wilmington, Delaware (302-658-8541)
Facilities: Bridgeport, N.J.
Baton Rouge, La.
Houston, Texas
Can handle solids and liquids by incineration.

9. Texas Ecologists, Inc.
Robstown, Texas (512-387-3513)
Disposal by landfill.

10. Wes Con, Inc.
Twin Falls, Idaho (208-733-0897)
Receive packaged materials for disposal in missile silos.

See note on other side

american national standards institute, inc.

Address Secretary at:
National Electrical Manufacturers Association
155 East 44th St., New York, N. Y. 10017
Telephone: 212-682-1500

May 8, 1975

TO ALL MEMBERS OF THE AMERICAN NATIONAL
STANDARDS COMMITTEE, C107, ON USE AND
DISPOSAL OF ASKAREL AND ASKAREL-
SOAKED MATERIALS FOR ELECTRICAL EQUIPMENT

SUBJECT: STATUS OF EPA ACTIVITY ON TOXIC POLLUTANTS

Gentlemen:

As you are aware, the Chairman has been withholding the call for the next meeting until the required announcement of EPA's expected revised levels for polychlorinated biphenyls and scheduling of a new round of Hearings is made in the Federal Register. It is understood that the announcement may not be forthcoming until the EPA has completed the evaluation stage required under the applicable public law.

For your information of what is involved in this evaluation, in general and specifically for toxic pollutants, a copy of the third draft of EPA's Water Quality Strategy Paper is attached as EXHIBIT "A". As an indication of the problems facing the EPA in its strategy planning, a copy of the minutes of a recent EPA meeting with Staff representatives from NEMA and other leading industry Associations is attached as EXHIBIT "B".

Also, for your information, the Chairman of ANSI C107 attended a recent meeting of EPA's Effluent Standard and Water Quality Information Advisory Committee, on the establishment of Workshops to be scheduled in selected industries, in order to develop inputs for EPA's evaluation program. As developments in this work that would be of interest to this Committee arise, you will be kept informed on them.

Sincerely yours,

A. M. Salazar, Secretary

AMS:dk
Att:
CC: K. Adgate
J.J. Cawley
M.A. Pisciotta
J. T. Mack (EIA)
S.L. Sherr

NPC00007728

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american national standards institute, inc.

Address Secretary at:
National Electrical Manufacturers Association
155 East 44th St., New York, N. Y. 10017
Telephone: 212-682-1500

August 18, 1972

TO ALL MEMBERS OF THE ANSI
COMMITTEE, C107, ON USE AND
DISPOSAL OF ASKAREL AND
ASKAREL-SOAKED MATERIALS
(SEE APPENDIX #1 FOR ROSTER OF MEMBERSHIP)

SUBJECT: MEETING NOTICE

Gentlemen:

The Chairman, Mr. W. P. Papageorge, has called a meeting for Tuesday, October 3, 1972. At the invitation of Dr. Stanley P. Wasik, of the National Bureau of Standards, the meeting will again be held at the NBS facilities in Gaithersburg, Md.

The meeting will convene at 9:00 A.M. and it is anticipated that the agenda should be completed by 4:00 P.M., at the latest. As in the case of the Organization meeting, luncheon will also be available in the NBS cafeteria. We have made arrangements for a tentative block of rooms for out-of-towners for late arrival on the night of Monday, October 2, 1972, at the Sheraton Hotel in Silver Springs, Maryland. ALL MEMBERS ARE URGED TO FILL OUT THE ATTACHED RESERVATION CARD AND FORWARD IT TO THE HOTEL IMMEDIATELY.

Limousine service to this hotel is readily available at the Washington National Airport and the NBS will again provide buses for the morning trip to the NBS and the afternoon return trip directly to the airport. All members are requested to assemble in the lobby of the hotel at 8:30 A.M. sharp for the morning bus.

The purpose of the meeting is to review the enclosed draft proposal for "Guidelines for Handling and Disposal of Capacitor and Transformer Grade Askarels Containing Polychlorinated Biphenyls" and take appropriate action with respect to it. This draft was only recently completed by the Capacitor and Transformer Working Groups, the rosters of which are given in APPENDICES #2 and #3, respectively, for your information.

The Chairman URGES all members to carefully review the draft ahead of the meeting to assure that the time spent at the meeting by all of us will be as productive as possible. Towards this end, any questions that members wish to have answered ahead of time should be rushed to the Chairmen of the Working Groups, so that they will be better prepared to help clear the way for positive action.

-cont'd- - -

NPC00007729

770368

A limited number of extra copies of the draft are available, for those who must clear them with others in their respective organizations. In view of the rather close timing before the meeting, all requests should be rushed to the Secretary by telegram or telephone, IMMEDIATELY.

You are also URGED to fill out and return the attached attendance card to the Secretary IMMEDIATELY.

Looking forward to seeing you at the meeting, I remain,

Sincerely yours,

A. M. Salazar, Secretary
ANSI C107 Committee

AMS:dk
Enc.
Att:
CC: J.O. Gustafson (Bailey Meter Company)
E.G. Hammer
R.J. Mindlin (National Cash Register Co.)
R.L. Rollins
T.K. Sloat

H.P. Michener (w/o enclosure)
J.G. Werner "
J.J. Kark "
C.A. Parris "

NPC00007730

770369

PERSONNEL OF ANSI COMMITTEE, C107 ON USE AND DISPOSAL OF ASKAREL AND ASKAREL-SOAKED MATERIALS

SCOPE: Procedures and guides for the safe use, maintenance and disposal of askarel and askarel-soaked materials used in electrical equipment.

CO-SECRETARIATS: MONSANTO-NEMA

ADMINISTRATIVE SECRETARIAT: NEMA

CHAIRMAN:
W. P. Papageorge
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Mo. 63166 314-694-1000

SECRETARY: A. M. SALAZAR, NEMA

ORGANIZATION REPRESENTED:	NAME AND BUSINESS AFFILIATION	
NATIONAL		
Certified Ballast Manufacturers Assoc. (CBMA)	N. R. Clark Universal Manufacturing Company 902 Crescent Ave. Bridgeport, Conn. 06607	203-336-0161
	Dr. A. Pozefsky General Electric Company Industrial & Power Capacitor Products Dept. John Street Hudson Falls, N. Y. 12839	518-747-3341
Electric Light & Power (ELP)	F. R. Lengefeld Union Electric Co. Box 149 St. Louis, Mo. 63166	314-621-3222
	H. A. Onishi Commonwealth Edison Co. 1319 So. First Ave. Maywood, Ill. 60153	312-294-4321
	Alternate: J. P. Markey Edison Electric Institute 90 Park Ave. New York, N. Y. 10016	212-986-4100

APPENDIX #1

NPC00007731

770370

ORGANIZATION REPRESENTED	NAME AND BUSINESS AFFILIATION	
Electronic Industries Association (EIA)	Arnold S. Doty Technical Services Laboratory P. R. Mallory & Co. Inc. P.O. Box 706 Indianapolis, Ind. 46206	317-261-1621
Institute of Electrical & Electronic Engrs. Inc. (IEEE)	E. L. Raab General Electric Company Power Distribution Division 100 Woodlawn Ave. Pittsfield, Mass. 01201	413-494-4385
National Elec'l Mfrs. Assn. (NEMA)	W. S. Grogan Power Distribution Division Allis-Chalmers Corporation Columbus & Preble Aves. Pittsburgh, Pa. 15233	412-322-4400
	R. D. McClain Westinghouse Electric Corporation P.O. Box 341 Bloomington, Ind. 47402	812-332-4421
	Ken McGee Sangamo Electric Company P.O. Box 359 Springfield, Ill. 62705	217-544-6411
	W. C. Reinhardt Central Moloney Transformer Division Colt Industries P.O. Box 101 St. Louis, Mo. 63166	314-383-3300
	H. R. Rowe McGraw-Edison Power Systems Division P.O. Box 160 So. Milwaukee, Wis. 53172	414-762-2500
GOVERNMENT Department of the Army	D. M. Crabtree Facilities Engg. Division Office of the Chief of Engineers Department of the Army Washington, D. C. 20314	202-693-6567
Environmental Protection Agency	Dr. Kenneth J. Hood Environmental Protection Agency Measurements & Instrumentation Branch Washington, D. C. 20460	202-522-1972

NPC00007732

770371

ORGANIZATION REPRESENTED	NAME AND BUSINESS AFFILIATION
General Services Administration	Charles C. Travis Federal Supply Service, Room 511 General Services Administration Washington, D. C. 20406
	Aaron J. Woloshin Office of Environmental Affairs General Services Administration Washington, D. C. 20405
National Bureau of Standards	Dr. Stanley P. Wasik National Bureau of Standards Room A145 Chemistry Building Washington, D. C. 20234
Rural Electrification Administration	Dr. John Leutritz, Jr. Timber Products Specialist Distribution Engineering Branch Power Supply, Manager and Engg. Standards Division Rural Electrification Administration Department of Agriculture Washington, D. C. 20250
Tennessee Valley Authority	William R. Nicholas Division of Environmental Research and Development Office of Health and Environmental Science Tennessee Valley Authority Chattanooga, Tenn. 37401
INDIVIDUALS	H. A. Alsentzer Rollins-Purle Inc. P.O. Box 2349 Wilmington, Delaware 19899
	P. G. Benignus Monsanto Company 800 N. Lindbergh Blvd. St. Louis, Mo. 63166 314-694-1000
	C. W. Hart Rollins-Purle Inc. P.O. Box 2349 Wilmington, Delaware 19899
	A. O. Hauser Electrical Utilities Company 2427 St. Vincent Ave. La Salle, Ill. 61301

NPC00007733

770372

ORGANIZATION REPRESENTED INDIVIDUALS	NAME AND BUSINESS AFFILIATION	
	Jules S. Lapides Gilbert Associates, Inc. 525 Lancaster Ave. Reading, Pa. 19603	215-376-3873
	Dr. E. M. Moore Electrical Utilities Company 2427 St. Vincent Ave. La Salle, Ill. 61301	815-223-1732
	W. P. Papageorge Monsanto Company 800 N. Lindbergh Blvd. St. Louis, Mo. 63166	314-694-1000
	A. L. Rickley Doble Engineering Company 32 Locust Street Belmont, Mass.	617-489-2830
	Louis E. Wagner Chem-Trol Pollution Services Inc. 4818 Lake Ave. Blasdell, N. Y. 14219	
	P. Williamson Rollins-Purle Inc. P.O. Box 2349 Wilmington, Delaware 19899	

NPC00007734

770373

OF THE ANSI COMMITTEE, C107,
ON USE AND DISPOSAL OF ASKAREL-SOAKED MATERIALS

CHAIRMAN:

Dr. A. Pozefsky
General Electric Company

N. R. Clark
Universal Manufacturing Co.
902 Crescent Ave.
Bridgeport, Conn. 06607
(203-336-0161

A. S. Doty
Technical Services Laboratory
P. R. Mallory 7 Co. Inc.
Indianapolis, Ind. 46206
(317-261-1629)

E. G. Hammer
McGraw-Edison Power
Systems Division
P.O. Box 160
So. Milwaukee, Wis. 53172
(414-762-2500)

R. D. McClain - Harvey Pickett, alt.
Westinghouse Electric Corp.
P.O. Box 341
Bloomington, Ind. 47402
(812-332-4421)

Ken McGee
Sangamo Electric Company
P.O. Box 359
Springfield, Ill. 62705
(217-544-6411)

Dr. E. M. Moore
Electrical Utilities Company
2427 St. Vincent Ave.
La Salle, Ill. 61301
(815-223-1732)

H. A. Onishi
Commonwealth Edison Co.
1319 So. First Ave.
Maywood, Ill. 60153
(312-294-4321)

Dr. A. Pozefsky
General Electric Company
Industrial & Power Capacitor
Prods. Department
John Street
Hudson Falls, N. Y. 12839
(518-747-3341)

R. L. Rollins
Jard Company Inc.
Bennington, Vt. 05201
(802-442-3173)

EX OFFICIO

P. G. Benignus
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Mo. 63166
(314-694-1000)

W. P. Papageorge
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Mo. 63166
(314-694-1000)

APPENDIX #2

NPC00007735

770374

WORKING GROUP ON TRANSFORMERS
OF THE ANSI COMMITTEE, C107,
ON USE AND DISPOSAL OF ASKAREL-SOAKED MATERIALS

CHAIRMAN: E. L. Raab
General Electric Company

M. Crabtree
cilities Engg. Division
fice of the Chief of Engineers
partment of the Army
shington, D. C. 20314
02-693-6567)

S. Grogan
all Power Department
lis-Chalmers Corporation
lumbus & Preble Aves
ttsburgh, Pa. 15233
12-322-4400)

R. Lengefeld
ion Electric Co.
O. Box 149
. Louis, Mo. 63166
14-621-3222)

L. Raab
emical & Processes Section
neral Electric Company
0 Woodlawn Ave.
ttsfield, Mass. 01201
13-494-4385)

W. C. Reinhardt
Central Moloney Transformer Division
Colt Industries
P.O. Box 101
St. Louis, Mo. 63166
(314-383-3300)

A. L. Rickley
Doble Engineering Co.
32 Locust St.
Belmont, Mass. 02178
(617-489-2830)

T. K. Sloat
Westinghouse Electric Corporation
Sharpsville Ave.
Sharon, Pa. 16146
(412-981-1611)

EX OFFICIO

G. Benignus
nsanto Company
0 N. Lindbergh Blvd.
. Louis, Mo. 63166
14-694-1000)

W. P. Papageorge
Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Mo. 63166
(314-694-1000)

APPENDIX #3

NPC00007736

770375

PCBD
TECHNICAL DOCUMENTS SCREEN

PFNO: 770368 - 770375

DSNO: NRC0000 7729 - 00007736

EXNO:

TYPE: Letter

AUTH: Salazar

INST: ANSI

TITL: Subject: meeting NOTICE

PAGS: 8

DATE: 720818

DIRC:

SRCE: West pro.

KWDS: capacitor, transformer, ANSI C107, meeting

KNMS: Wasik / National Bureau of Standards; Gustafson / Bailey Meter Co.; Mindlin / Consl Register Co.; Hammer, Sloat, Rollins, Miclener, Werner, Kark, Parris

FLD1:

FLD2:

COMM: Meeting of ANSI C107 on 10/3/72; purpose is to review draft proposals for guidelines for handling and disposal of capacitor and transformer askarels. List begins on PFNO 770370 - 770375

american national standards institute, inc.

Address Secretary at:
National Electrical Manufacturers Association
155 East 44th St., New York, N. Y. 10017
Telephone: 212-682-1500

C107

October 4, 1974

TO ALL MEMBERS OF THE ANSI
COMMITTEE, C107, ON USE AND
DISPOSAL OF ASKAREL AND
ASKAREL-SOAKED MATERIALS FOR
ELECTRICAL EQUIPMENT

SUBJECT: PRELIMINARY NOTICE FOR NEXT MEETING

Gentlemen:

Mr. W. P. Papageorge, Chairman, anticipates that the EPA will soon issue new levels for toxic pollutants, including PCB's, which will be the subject of new EPA Hearings, during the month of January, 1975. It was the consensus at Monsanto's Dielectrics Seminar, held on September 23, 1974, in St. Louis, that the ANSI C107 Committee should provide the forum for review of developments and interchange of opinions, in preparation for the new Hearings.

In view of the above and other open agenda items, the Chairman requested me to issue this notice and URGE all members to mark their calendars for a meeting, possibly in the early part of January, 1975. You will be informed of the exact date, as soon as the schedule for the new EPA Hearings becomes available.

Your cooperation is requested in providing me with, (1) a list of dates in January that you would be available for a meeting and, (2) any roster changes that may have occurred since the last meeting. A postcard and a copy of the current roster is attached for this purpose.

Sincerely yours,

A. M. Saldzar, Secretary

AMS:dk
Att:

NPC00007737

770376

ORGANIZATION REPRESENTED:	NAME AND BUSINESS AFFILIATION	CLASSIFICATION (SEE SUMMARY)
Electronic Industries Association (EIA)	Arnold S. Doty Technical Services Laboratory P. R. Mallory & Co. Inc. P.O. Box 706 Indianapolis, Ind. 46206 (317-261-1621)	M
Institute of Electrical & Electronic Engrs. Inc. (IEEE)	E. L. Raab General Electric Company Power Distribution Division 100 Woodlawn Ave. Pittsfield, Mass. 01201 (413-494-4385)	S
National Electrical Mfrs. Assn. (NEMA)	Dr. K. C. Chang Central Moloney Transformer Division Colt Industries P.O. Box 101 St. Louis, Mo. 63166	M
	W. S. Grogan Power Distribution Division Allis-Chalmers Corp. Columbus & Preble Aves. Pittsburgh, Pa. 15233 (412-322-4400)	M
	R. D. McClain Westinghouse Electric Corp. P.O. Box 341 Bloomington, Ind. 47402 (812-332-4421)	M
	H. R. Rowe McGraw-Edison Power Systems Division 1520 Emerald Rd. Greenwood, So. Carolina 29646 (803-223-2311)	M
	Alternate: Ken McGee Sangamo Electric Company P.O. Box 359 Springfield, Ill. 62705 (217-544-6411)	
GOVERNMENT Department	D. M. Crabtree Facilities Engg. Division Office of the Chief of Engineers Department of the Army Washington, D. C. 20314 (202-693-6577)	G

NPC00007738

770377

ORGANIZATION REPRESENTED	NAME AND BUSINESS AFFILIATION	CLASSIFICATION (SEE SUMMARY)
GOVERNMENT (CONT'D)		
Environmental Protection Agency	Dr. Kenneth J. Hood Environmental Protection Agency Measurements & Instrumentation Branch Washington, D. C. 20460 (202-522-1653)	G
General Services Administration	Charles C. Travis Federal Supply Service, Room 511 General Services Administration Washington, D. C. 20406	G
National Bureau of Standards	Dr. Stanley P. Wasik National Bureau of Standards Room A145 Chemistry Building Washington, D. C. 20234	G
Rural Electrification Administration	Dr. John Leutritz, Jr. Timber Products Specialist Distribution Engineering Branch Power Supply, Manager and Engg. Standards Division Rural Electrification Administration Department of Agriculture Washington, D. C. 20250	G
Tennessee Valley Authority	William R. Nicholas Division of Environmental Research and Development Office of Health and Environmental Science Tennessee Valley Authority Chattanooga, Tenn. 37401	G
Rollins-Purle Inc.	H. A. Alsentzer Rollins-Purle Inc. P.O. Box 2349 Wilmington, Delaware 19899	S
Electrical Utilities Company	A. O. Hauser Electrical Utilities Company 2427 St. Vincent Ave. La Salle, Ill. 61301 (815-223-1732) Alternate: Dr. E. M. Moore	M
Gilbert Associates Inc.	R. J. Schatz Gilbert Associates, Inc. 525 Lancaster Ave. Reading, Pa. 19603 (215-376-3873)	S

NPC00007739

770378

ORGANIZATION REPRESENTED	NAME AND BUSINESS AFFILIATION	CLASSIFICATION (SEE SUMMARY)
Monsanto Company	W.P. Papageorge Monsanto Company 800 N. Lindbergh Blvd. St. Louis, Mo. 63166 (314-694-1000)	M
Doble Engineering Company	A. L. Rickley Doble Engineering Company 32 Locust St. Belmont, Mass. (617-489-2830)	S
Chem-Trol Pollution Services Inc.	Louis E. Wagner Chem-Trol Pollution Services Inc. P.O. Box 200 Model City, N. Y. 14107 (716-754-8231)	S

SUMMARY

M	Manufacturers	9
U	Utilities	2
S	Specialists	5
G	Government	6
		22

NPC00007740

770379

National Electrical Manufacturers Association
155 East 44th Street • New York, N.Y. 10017 • 212-682-1500

C-1739

May 24, 1971

File: 11.C107

TO THE NEMA REPRESENTATIVES
ON THE ANSI C107 COMMITTEE

Subject: NEMA Representation on ANSI Standards Committee on Disposal of Askarel Used in Electrical Equipment, C107

Gentlemen:

I assume that you have already received a copy of my May 4th letter notifying you of your appointment to the subject C107 Committee.

In the attachment, wherein the NEMA delegation was listed, we erroneously listed Mr. R. D. McClain of Westinghouse at Sharon, Pa. in lieu of Bloomington, Ind.

Attached is a corrected listing of the NEMA delegation on C107.

Very truly yours,

Bess Fierro

Bess Fierro, Administrative Assistant - Engineering
Engineering and Safety Regulations Department

attach.
cc: D. L. Peyton - ANSI
W. B. Papageorge, Chrmn. C107 Comm.
A. M. Salazar, Secy. C107 & TR Sect.
C. A. Parris - CP Sect.
J. J. Kark

NPC00007741

770380

ANSI STANDARDS COMMITTEE ON DISPOSAL OF ASKAREL USED IN ELECTRICAL EQUIPMENT, C107

SCOPE: Procedures and guides for the safe use, maintenance and disposal of askarel and askarel-soaked materials used in electrical equipment.

NEMA DELEGATION:

W. C. Reinhardt, Chairman NEMA Delegation	Central Moloney Transformer Division, Colt Industries P. O. Box 101 St. Louis, Mo. 63166
D. E. Allen	Allis-Chalmers Mfg. Co. Columbus & Preble Aves. Pittsburgh, Pa. 15233
J. F. Kuzela	Sangamo Electric Company P. O. Box 359 Springfield, Ill. 62705
R. D. McClain	Westinghouse Electric Corp. P. O. Box 341 Bloomington, Ind. 47402
H. R. Rowe	McGraw-Edison Power Systems Division P. O. Box 160 So. Milwaukee, Wisc. 53172

5/4/71

NPC00007742

Westinghouse

INVERTEEN INTERTEEN® CAPACITOR

CAUTION

THIS PRODUCT CONTAINS POLYCHLORINATED BIPHENYL FLUID, WHICH STUDIES SHOW MAY BE AN ENVIRONMENTAL CONTAMINANT. CARE MUST BE TAKEN TO PREVENT ANY ENTRY TO THE ENVIRONMENT. DISPOSAL SHOULD BE IN ACCORDANCE WITH STATE AND FEDERAL LAWS.

MAKE THIS A PERIOD

Westinghouse Electric Corporation 159P053H01 MADE IN U.S.A.

NAMEPLATE 159P053H01

.022" THK. STAINLESS STEEL (BDS 7704-7) . . . FINISH

"Westinghouse" & ® TO BE NATURAL ON BLUE BACKGROUND.

ALL OTHER LETTERING TO BE BLUE ON NATURAL BACKGROUND.

4-1/8" DIA. HOLES.

2 1/4" BETWEEN CENTERS OF HOLES ON LONG EDGE OF PLATE.

1 3/8" BETWEEN CENTERS OF HOLES ON SHORT EDGE OF PLATE.

REDUCE TO 2 1/2" X 1 5/8" PROOF 2:1

Suppliers Note:-Return this Original Artwork Immediately to Westinghouse Electric Corporation, Printing Division, Trafford, Pa. 15085 Attn: Art Dept.

APPROVAL
AS NOTED
APPROVED BY: James J. McNally
DATE: CAPACITOR BLDG 8/21/70

Please send approval print to:
Clyde Hobbs
[illegible]

NPC00007215

769854

PCB IMPREGNATED CAPACITORS - PRESENT STATUS

Because of the pressure to phase out the use of PCBs in capacitors, for environmental reasons, and because the prospective introduction of a substitute raises many questions which a number of organizations and agencies are going to have to face and to resolve collectively, we believe it is useful to take time for a brief overview of our present product--some of its principal features, and why it is made as it is. We are going to need to weigh carefully the feasibility of, and the effect of deviating from the present product, whether the deviation be in size, reliability, fire resistance or whatever; in order to do that, we need to know what we are "deviating from".

Almost all capacitors made for alternating [illegible] application in the United States are impregnated with a particular variety of polychlorinated [illegible] by Monsanto, and identified by the trad[illegible] capacitor manufacturers adapt this material [illegible] processing procedures, with or without additives, their dielectric liquids by such trade names [illegible] Dykanol, Nyvol, Euterol, Clor[illegible], Clor[illegible] The generic term for this type of dielectric liquid is askarel. This particular variety of PCB has been used by the capacitor industry since about the first of 1972. The principal difference from its predecessor (Aroclor 1242) is that most of the higher

boiling homologues have been removed, leaving the lower chlorinated and therefore more biodegradable fractions.

The family of polychlorinated biphenyls have characteristics which make them suitable for a wide variety of uses, which in the past have resulted in widespread entry into the environment. At present, usage is limited almost entirely to transformers and capacitors where Aroclors have been used since the early 1930s. Aroclor 1016 has a unique combination of several different characteristics which make it especially suited for use in AC capacitors. The most important of these, which are shared by no other known potential alternative, are:

1. High (approximately 5) dielectric constant, which results in small size, and efficient utilization of other capacitor materials such as electrical grade kraft paper and aluminum foil.
2. High stability to electrical, thermal and chemical stresses, which result [illegible] life and reliability.
3. Fire resistance. It has a [illegible] 358°F, no fire point to its [illegible] of 520°F, and has a UL class [illegible] "non-flammable".

Thus, capacitors impregnated with this material are characterized by small size, long life in service, exceptional reliability, and safety. All of these factors are important from the economic standpoint, but the last one mentioned: safety, has a special

importance in many of the applications for the type of capacitors we call "small industrial". As you no doubt know, these capacitors are used in the home in devices such as TV receivers, air conditioners, microwave ovens and the larger dehumidifiers ,and in whole host of commercial and industrial applications such as ballasts for fluorescent and high intensity discharge (e.g. mercury and sodium vapor) lamps.

Because of the compelling economic and safety considerations, the capacitor industry has spent untold millions of unit hours in testing the product which has evolved into present-day small industrial capacitor designs. The resulting product has an overall survival rate of more than 95% in the 12 to 15 year design life demanded by the capacitor users, with yearly failure rates of very substantially less than one percent. Even so, unforeseen circumstances have in the past resulted in abnormally high failure rates in particular instances. Capacitor manufacturers are therefore careful, even using the familiar existing materials and processes, [illegible] evaluations before introducing into product[illegible] designs which represent seemingly modest departures from past practice.

One approach to product safety has been to incorporate circuit interrupting devices, either in the capacitors themselves, or in the circuit in which they are used. Examples are the pressure or thermally sensitive circuit interrupters sometimes used in fluorescent lamp ballast capacitors, and electrical fuses either built-in or used in the external cir-

cuit of capacitors used in air conditioners. Aside from considerations of providing protection against damage to associated devices, the intent of such protective means is to prevent rupture of the can in the event of capacitor failure. Because with the present PCB impregnant the fire hazard from can rupture has been regarded as minimal, such protection has not been used very extensively in the past few years.

In summary, small industrial capacitors are a tried and proven product which is made from readily available materials, are relatively small, inexpensive, reliable and fire resistant, and we have literally hundreds of millions of them operating successfully as components in a wide variety of domestic, commercial and industrial equipment. In the subsequent discussion, we will be reviewing a variety of points, including wh. it appears to be necessary to make a significant change.

N. Ray Clark
Universal Man.
for: EIA Ad Hoc

NRC/h
3/1/76

Contact: J. P. Daley
Telephone: (412) 255-3363

FOR USE: At Will

PITTSBURGH, Nov. 24 -- Since the late 1930's, the electrical industry has supplied transformers using askarels which contain PCB's (polychlorinated biphenyls) for use in installations where a high degree of fire resistance is required, such as schools, hospitals and high-rise buildings. In addition, major applications of PCB's were carbonless paper, fire resistant hydraulic fluids, heat transfer fluids and plasticizers. Moreover, capacitors containing PCB's are used in fluorescent lighting ballasts, air conditioning units and television receivers.

In late 1970 studies began to show that PCB's persist and accumulate in the environment. Since that time, Westinghouse has attached an additional identifying label to each transformer.

Westinghouse said recent tests indicate that mineral oil-filled transformers may contain varying concentrations of PCB's.

The company said the presence of PCB's in mineral oil does not affect the performance of the transformers.

- more -

NPC00007220

769859

Currently there are no nationally established standards for allowable levels of PCB's in oil for closed electrical systems. A number of states have recently enacted legislation providing for special reporting, labeling and/or disposition of PCB's. Because legislation varies in different states, it is suggested that customers institute any special procedures which may be required for conformance.

In addition, when performing repair, routine maintenance or disposal, oil-filled transformers should be checked for the presence of PCB.

On November 8, the National Electrical Manufacturers Association (NEMA) commissioned a special task force to study the possibility that PCB's may be present in detectable quantities in oil-filled electrical apparatus and oil-storage systems for electrical insulating oil.

##2610-71##

NPC00007221

769860

PROPOSED PRESS RELEASE

PCB's PRESENCE IN OIL-FILLED TRANSFORMERS

Since the late 1930's, the electrical industry has supplied transformers using askarels which contain PCB's (Polychlorinated Biphenyls) for use in installations where a high degree of fire resistance is required, such as schools, hospitals and high-rise buildings. In addition, major applications of PCB's were carbonless paper, fire resistant hydraulic fluids, heat transfer fluids and plasticizers. Moreover, capacitors containing PCB's are used in fluorescent lighting ballasts, air-conditioning compressors, and television receivers.

In late 1970 studies began to indicate that PCB's had a tendency to persist and accumulate in the environment. Since that time, Westinghouse has attached an additional identifying label to each [illegible] transf[illegible] shipped.

Westinghouse said recent tests [illegible] filled transformers may contain varying [illegible] of PCB's

The company said the presence of PCB's in mineral oil does not [illegible] the performance of the transformers.

NPC00007222

769861

Currently there are no nationally established standards for allowable levels of PCB's in oil for closed electrical systems. A number of states have recently enacted legislation providing for special reporting, labeling and/or disposition of PCB's. Because legislation varies in different states, it is suggested that customers institute any special procedures which may be required for conformance.

In addition, when performing repair, routine maintenance or disposal, oil-filled transformers should be checked for the presence of PCB.

On November 8, the National Electrical Manufacturers Association (NEMA) commissioned a special task force to study the possibility that PCB's may be present in detectable quantities in oil-filled electrical apparatus and oil-storage systems for electrical insulating oil.

###

FILE
INERTEEN

From: Sharon Works, ML-017
W/T: 224-4387
Date: May 7, 1970
Subject: INERTEEN Environmental Contamination

Power Transformer Engineering Managers
Distribution Transformer Engineering Managers
District Engineers
M. & R. Shop Managers
Electric Service Engineers

We should all be familar with the attached notification received February 18, 1970 from the Monsanto Company on the above subject. They are the sole manufacturer of askarels which includes INERTEEN used in various types of Westinghouse transformers and capacitors.

Askarels are synthetic insulating fluids made by the chlorination of a relatively common chemical, bi-phenyl. (Polychlorinated Bi-phenyl) (PCB). It nas been well established by several laboratories that measureable amounts of the PCB's have been found in our general environment and have been shown to be detrimented to some forms of wiid life. No maximum allowable levels have been established nor is there evidence of toxicity to humans.

Because of the current emphasis on pollution and these recent studies, it is evident that extreme care must be taken in disposing of askarels to prevent these fluids from further polluting the environment. While the electrical uses of the askarels provide sealed systems there still remains a problem of waste disposal when the equipment is [illegible] ness or during repair.

At the present time it is suggested [illegible] INERTEEN you should contact the Monsanto [illegible] material.

There is considerable work being done [illegible] problem to provide further information [illegible] of the fluids to make them less harmful [illegible].

T. K. Sloat
Fluid Insulation Section Manager

Attachment

/blr

NPC00007224

769863

FILE INSERT6H

Monsanto

ORGANIC CHEMICALS DIVISION

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

February 18, 1970

Dear Sir:

Recently several newspaper and magazine articles have been published indicating that Polychlorinated Biphenyls (PCBs) have been discovered at some points in some marine, aquatic and wildlife environments. The quantities detected are said to be in the parts per million and parts per billion categories.

It is claimed that the PCBs found strongly resemble chlorinated biphenyls containing 54% and 60% chlorine by weight. Products which are sold by Monsanto under the trade names of Aroclor® 1254 and 1260 do contain chlorinated biphenyls. In addition to Aroclor® 1254 and 1260, Monsanto sells certain functional fluids containing Aroclor® 1254. These include Pydraul® 625, Pydraul® AC, Pydraul® AC - Winter Grade, Pydraul® 540, Therminol® FR-3 and certain dielectric formulations. Other companies around the world also produce products containing chlorinated biphenyls.

As your supplier of Aroclor® 1254 and 1260 and formulated products containing 1254, we wish to alert you to the potential problem of environmental contamination as referred to in the newspaper and magazine articles.

We would like to point out the following additional facts:

1. Products such as Pydraul® 90, 135, 230, 312, A-200, F-9, 150, and 60, Turbinol® 153 and Therminol® FR-1 and FR-2 are not formulated with Aroclor® 1254 or 1260.

2. PCBs with a chlorine content of less than 54% have not been found in the environment and appear to present no potential problem to the environment.

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We have developed, and are now testing, new formulations to replace the Aroclor®1254 and 1260 components in our Pydraul® products. The new products appear to be equal in performance and to have similar physical properties.

We feel that all possible care should be taken in the application, processing and effluent disposal of these products to prevent them becoming environmental contaminants. Of interest to you may be an article in Chemical Week, October 29, 1969, regarding water pollution standards set by each state in the Union. It is attached. This article reflects that good manufacturing practice in the future may require that no product used by any company should find their way into waterways.

We realize that you have marketed or may now market transformers and other electrical equipment containing dielectric fluids which include Aroclor® 1254 and 1260. Although these fluids are sealed into such equipment it is recognized that occasionally the fluid may be lost through leaks resulting from equipment misuse or equipment repair necessitating replacement of the fluid. Since the dielectric fluid contained in this equipment is only an incidental part of the over-all unit manufactured by you, we are not notifying the purchasers of such equipment of the potential environmental contamination problem described in this letter. We do recommend, however, that you notify such equipment users of this problem.

Sincerely yours,

Do
Dir.

lb

Attachment

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Westinghouse Electric Corporation

Distribution Apparatus Division Box 341, Bloomington, Indiana 47

September 4, 1970

Endurance Electric Pty. Limited
Bapaume Road, Morebank, N.S.W.
P. O. Box 315, Liverpool, N.S.W.
Australia 2170

ATTENTION: Mr. L. Lechowicz, General Manager

Dear Mr. Lechowicz:

SUBJECT: INERTEEN AND ENVIRONMENTAL CONTAMINATION

In the past several months our supplier of chlorinated biphenyl (Inerteen), Monsanto Chemical Company, has made us aware of the increasing interest in the possibility that indiscriminant distribution of polychlorinated biphenyls (PCB's) may result in environmental contamination.

We are taking this opportunity to provide you with copies of information supplied to our people who make customer contacts, in order that they might offer suitable advice on the disposition of Arochlor fluid and Arochlor saturated materials in the course of making apparatus repairs, replacements, or disposing of obsolete equipment.

Process specifications, being adapted to [illegible] ing operations are also enclosed. Like[illegible] the CAUTION plate, to be attached to eac[illegible] after October 1, 1970, is included.

We trust this information may be useful to [illegible] your own position in this matter.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION
Bloomington, Indiana

Robert D. McClain

Robert D. McClain, Manager
Capacitor Unit Engineering

Attachments

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MAILED
1-24-72

January 15, 1972

Monsanto Industrial Chemicals Co.
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166

Gentlemen:

Monsanto Company ("Monsanto") manufactures certain polychlorinated biphenyl products ("PCB's") which Westinghouse Electric Corporation ("Buyer") desires to purchase. While Buyer desires to purchase PCB's because of certain desirable flame resistant and insulator properties, Buyer acknowledges that it is aware and has been advised by Monsanto that PCB's tend to persist in the environment; that care is required in their handling, possession, use and disposition; that tolerance limits have been or are being established for PCB's in various food products.

Monsanto has therefore adopted certain restrictive policies with respect to its further production, sale and delivery of PCB's, including the receipt of undertakings from its customers as set forth below, and Buyer is willing to agree to such undertakings with respect to sales and/or deliveries of PCB's by Monsanto to Buyer.

Accordingly, Buyer hereby covenants and agrees with respect to any and all PCB's sold or delivered by or on behalf of Monsanto to or for the account of Buyer on or after the date hereof, and in consideration of any such sale or delivery, Buyer shall defend, indemnify and hold harmless Monsanto, its present, past and future directors, officers, employes and agents, from and against any and all liabilities, claims, damages, penalties, actions, suits, losses, costs and expenses arising out of or in connection with the receipt, purchase, possession, handling, use, sale or disposition of

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In the event of litigation to which these indemnity provisions shall apply, Monsanto will make available to Buyer such information as Monsanto has (excluding trade secrets or proprietary information of Monsanto, or any other information which Monsanto is not legally free to disclose) which may reasonably be required by Buyer in the defense of such litigation, and otherwise will cooperate with Buyer in connection therewith.

This agreement shall be governed by and be construed according to the laws of the State of Missouri.

All existing contracts for the sale of PCB's by Monsanto to Buyer for delivery in the future are hereby amended to contain the provisions set forth herein.

WESTINGHOUSE ELECTRIC CORPORATION

By /s/ S. W. Herwald

Title Vice President

Date January 15, 1972

MONSANTO CO

By _____

such PCB's by, through or under Buyer, whether alone or in combination with other substances, including, without implied limitation, any contamination of or adverse effect on humans, marine and wildlife, food, animal feed or the environment by reason of such PCB's.

The point at and after which the provisions of this agreement shall apply to PCB's sold or delivered by or on behalf of Monsanto to or for the account of Buyer on or after the date hereof, and the point at which title and risk of loss with respect to such PCB's shall pass from Monsanto to Buyer, shall be the F.O.B. point at the location from which delivery to Buyer is initiated by Monsanto, and shall refer to the point of transfer of possession of the drum, tank car, tank truck, or other container for such PCB's, from Monsanto to Buyer or the first receiving carrier utilized to effect delivery of such PCB's to Buyer.

The provisions of this agreement shall not be applicable to any PCB's delivered to Buyer prior to the date hereof; and nothing herein shall create or imply any duty or obligation (i) of Monsanto to sell or deliver any PCB's to Buyer; or (ii) of Buyer to defend, indemnify or hold harmless Monsanto or any other corporation, or any person, for any damages resulting from the negligence of Monsanto (in the absence of negligence of Buyer) in its packaging or shipping or from the failure of PCB's to comply with the specifications applicable to such PCB's. No conditions or agreements purporting to modify or vary the terms shall be binding unless hereafter made in writing referring to this agreement and signed by the party to be bound and no modification or variance of this agreement shall be effected by the acknowledgment or acceptance of any sales document, purchase order, shipping instruction or other form containing terms or conditions at variance herewith.

Chicago, December 15, 1971

MEETING ANSI C-107
USE AND DISPOSAL OF ASKARELS AND
ASKAREL SOAKED MATERIALS

PRESENT:

Transformer Group

E. L. Raab, General Electric
W. S. Grogan, Allis-Chalmers
F. R. Lengefeld, Union Electric
W. C. Reinhardt, Central Moloney
A.C. Rickley, Doble Eng.
T. K. Sloat, Westinghouse

Capacitor Group

A. Pozefsky, General Electric
N. R. Clark, Universal Mfg. Co.
E. G. Hammer, McGraw Edison
R. D. McClain, Westinghouse
E. M. Moore, Electric Utilities

P. G. Benignus, Monsanto, Ex. Officer
W. P. Papageorge, Monsanto, Ex. Officer
A. M. Salazer, ANSI

The meeting opened with Mr. Papageorge presenting the lastest information on the government status on the PCB's.

1. The Toxic Chemical Act will probably not be passed by the present congress but it appears fairly certain it will be handled under this act, that is, the controls on PCB's.

2. 22 Other Congressmen have now co-sponsored a third bi . of Congressmen Ryan banning all PCB's. It does not appear as though this bill will get out of committee.

3. The EPA has been active in Alabar . e Mons effluent from the plant contained ar . 50-100 p. on the flow represented about 0.3#/day. This is on a long term basis.

4. The state of Michigan's Water Resource Commissi . has been attacking big industry for PCB's in water effluent coming fr hydraulic systems. A zero level is required.

5. Several groups have raised the question of air contamination by PCB's but no studies are underway.

6. A meeting is to be held in Durham, N. C., December 20 and 21 sponsored by the National Institutes of Health to hear a group of papers by domestic and foreign scientists on their studies of PCB's and effects on human biology. Approximately 100 people will attend. Documents will be made available of this meeting.

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7. In spite of the vast amount of data available to the FDA they have not made a ruling or regulation on the PCB's.

8. Mr. Papageorge distributed to the members present production figures for the Aroclors from 1960 to date.

It was decided that Monsanto would prepare a fact sheet of the question and answer type for distribution to all interested parties. This fact sheet will be ready for review at the next committee meeting.

The committee then broke into the transformer and capacitor groups for work assignments.

Transformer Group

The following assignments were made to provide information to be made into an ANSI document.

1. Transformer manufacturing and repair guidelines for effective plant housekeeping and employee safety. - T. K. Sloat

2. Guide line limits for control of water and vapor effluents. - W. S. Grogan

3. Disposal of manufacturing solid and liquid scrap from production failures and/or contamination. - E. L. Raab

4. Guidelines for transformer users. - W. C. Reinhardt

5. Disposal of field failure solid and liquid scrap. - E. L. Raab

6. Standardized analytical procedures for water and air. - W. S. Grogan

7. Liquid and Solid disposal services. - A. L. Rickley

8. Warning Labels and disposal. - F. R. Bengefel

Each person is to submit drafts of his assignment to ... prior to next meeting for distribution to other members.

The following questions were proposed and answers by GE and Century Moloney given. Westinghouse and Allis Chalmers were asked to also respond.

1. An industry estimate of the number of askarel transformers are made each year.
   GE 5000 Moloney 3500

2. The average volume of liquid in an askarel transformer.
   GE 235 gal. Moloney 400 gal.

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3. An estimate of production failure rate.
   GE 1-1.3% Moloney 1.0%

4. An estimate of the failure rate of transformers in service.
   GE 0.2% Moloney 0.5%

5. An estimate of the total number of askarel transformers in service (cumulative).
   GE 100,000 Moloney 125,000

The following items were of interest:

1. The General Electric Company has on order an incinerator for April startup which will destroy liquids and solids soaked with askarel. They are considering making this service available to customers.

2. The General Electric Company is considering a vapotherm type of treatment of core and coil assemblies to wash out PCB's prior to scrapping the assemblies. It has been shown to be an efficient way to clean the askarel from the core and coil.

3. The General Electric Company at Pittsfield and Rome use Aroclor 1254, 85%, and tri-tetra chlorobenzene, 15% for all transformers.

The transformer and capacitor groups met again for final information. The assignments of the capacitor group were as follows.

1. Housekeeping and plant safety. - R. D. McClain

2. Guidelines for handling water and vapor effluents. - A. Forsfjäll

3. A.S.T.M. will be asked to provide methods for determination of Askarels in materials and air.

The next meeting will be held February ? and in Chicago. Individual assignment drafts to be se.

T. R. Sloat

Westinghouse Electric Corporation Power Systems Power Transformer Department
Highway 58 West, P.O. Box 920
South Boston, Virginia 24592

October 14, 1971

The Honorable William B. Spong
United States Senate
Washington, D.C. 20510

Dear Senator Spong:

During your consideration of the toxic substances legislation now before the Subcommittee on Environment of the Committee on Commerce, we would like you to be aware of our interest in the use and regulation of polychlorinated biphenyl fluids, commonly referred to by the acronym PCBs.

Here in South Boston we use PCB fluid as an insulator and coolant in power transformers which will be placed in buildings and in sidewalk vaults where fire could cause serious personal injury and property damage. At the present time, there is only one domestic manufacturer of this fluid, and despite continuing research, we have not yet found a satisfactory substitute for it.

Monsanto Chemical Company, our source, calls its product Aroclor. Westinghouse uses the name Inerteen for it. General Electric Company calls it Pyranol. Throughout the transformer and capacitor industries it is generically known as an Askarel fluid. Whatever the name, this PCB family of insulants is characterized by stability. They have a very high flash point and an even higher combustion temperature. These very qualities which make them ideal for our application also make the very persistent if allowed to escape in the atmosphere.

PCBs have attracted much public attention recently because unacceptable amounts have been found to be prevalent in some food areas, particularly birds and fish. They are

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suspected of being genetically damaging to these forms of life. For many years they have been used as a component of hydraulic fluids and heat transfer fluids. They have also been used in paints and as plasticizers--two applications where potentially toxic substances could be released to the environment. In our industry, their use is confined to electrical equipment where the tanks are sealed and the system is considered to have a "closed" cycle. It is our understanding that Monsanto Chemical Company now confines the sale of its PCBs to closed cycle system users.

As of this writing, an American National Standards Institute committee headed by a Monsanto Chemical Company representative has been organized to propose United States standards for the control and use of PCBs for electrical apparatus. Westinghouse is represented on this committee.

Westinghouse is working diligently in our own factories and research laboratories to find an alternate fluid for use in power transformers. To date we have been unsuccessful in finding a substitute that will meet the necessary insulation requirements and fireproof characteristics. Our capacitor people are trying out a substitute fluid for their application, but we do not have sufficient experience with it yet to establish reliable data on its performance characteristics or its biodegradability.

Inerteen-insulated power transformers constitute about one-fourth of our South Boston production. Our [illegible] 1971 requirement of Inerteen at this plant is expected approximately 375,000 gallons. While these transformer in some instances, be replaced by dry-type transformers. are many applications where dry-type installations are [illegible] To achieve the same electrical function with equivalent efficiency, a dry-type transformer is generally larger than transformer using Inerteen as an insulant, thus making it more costly. Moreover, many existing buildings and sidewalk vaults would have to be enlarged or modified to accommodate dry-type transformers.

Given the present state of the art, it would be fair to say that an economically and technically acceptable substitute liquid is not yet in prospect. More time is needed. Complete analysis of the technical data we are accumulating, weeding out those fluids lacking promise, would precede negotiation

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with potential suppliers on the basis of projected requirements to determine availability and cost. Full review of the economics of changing to a new dielectric liquid would further refine our potential substitutes. Exhaustive testing of the chemical characteristics of each possible alternate, its operational stability and compatibility with other materials used in our manufacturing process, would follow.

PCB-type materials have been used in the manufacture of power transformers for more than thirty years. There are many millions of gallons in transformers already in use throughout the United States, and this PCB material is as potentially hazardous as the like material in transformers currently being placed in use. Nevertheless, the total amounts used nationally in our type of product application are much less significant, for example, than the amounts of DDT-type materials which present a similar potential environmental hazard. Also, we reiterate that while DDT-type materials have been used largely in "open" applications, Inerteen is used by us in a "closed" system which, by its very nature necessitates monitoring by maintenance personnel with a relatively high degree of technical sophistication and competence. It does not seem, therefore, that there would be any significant increase in the potential national environmental hazard if the use of PCB-type materials were restricted to closed cycle systems for a reasonable period of time -- ample enough to permit industry to find suitable alternatives.

At our South Boston plant and elsewhere we are alert to the hazardous nature of this PCB we exercise high standards of control as we in our transformers in a closed circuit system. is made to insure against its escapement into through warnings to handling personnel (See Att special instructions to customers about draining sealed system, return of all waste liquid and materials to the PCB manufacturer for destruction in excess of 400°F, and monitoring of plant effluents Attachment B). Nevertheless, we approve legislation such as your Committee is considering, designed to protect environmental quality by prescribing high standards of control in all stages

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of the use and disposition of PCB material, including limiting its use to sealed or closed systems if deemed necessary; but we are concerned that polychlorinated biphenyls not be peremptorily banned from manufacture and use, since we believe the public can be adequately protected without such action. We would be most appreciative of your assistance in this matter and are prepared to supply you with any further information you might wish.

Sincerely,

John G. Aldworth
General Manager

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National Electrical Manufacturers Association
155 East 44th Street • New York N.Y. [illegible] • 212 682 1500

November 19, 1970

File: 11.00

Mr. Donald L. Peyton
Managing Director
American National Standards Institute
1430 Broadway
New York, N. Y. 10018

Subject: (Proposed) American National Standards Committee
On Disposal of Askarel Used In Electrical Equipment

Dear Mr. Peyton:

NEMA, upon recommendation by the Board of Directors of the Power Equipment Division, respectfully recommends that subject Proposed Standards Committee be established by the ANSI.

It is further recommended that NEMA and Monsanto Company be designated as Co-Secretariats of this new ANSI project, with NE[illegible] as the Administrative Secretariat.

These recommendations are concurred in by the Monsanto [illegible].

The purpose of the Proposed Standards Committee will

1 - Develop guides for the use and [illegible]
used in electrical equipment.

2 - Develop practical disposal procedures.

3 - Provide recommendations to interested [illegible]
standards bodies such as the IEC and CIGRE.

4 - To assume the leadership in the promulgation of guides and procedures, and their dissemination among all possible users.

Representation on the Proposed Standards Committee would be invited from all organizations considered to have substantial concern and would include:

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a) NEMA
b) Monsanto Company
c) Electric Light and Power Group
d) IEEE
e) ASTM
f) Government Power Agencies
g) Industrial Group; e.g. General Motors Corp., Ford Motor Company
h) Disposal Consultants

The Monsanto Company, manufacturer of askarels (technically known as polychlorinated biphenyls), has notified purchasers of askarels that there was a possibility of environmental contamination due to non-biodegradable materials used in their composition. The Monsanto Company has already taken steps to limit the availability of askarel to those uses where the fluid is essential and is contained in a closed system, such as is the case for transformers and capacitors. With the cooperation of transformer and capacitor manufacturers, steps have been taken to alert all known users on the problem and on corrective measures. Monsanto has also instituted a means for disposing of bulk fluid, and means are currently being investigated for disposing of askarel-soaked waste materials, coils, insulation, scrap, discarded capacitors, etc.

At a NEMA committee meeting held earlier this year, with key personnel of the Monsanto Company present by invitation, considerable concern was expressed on the following with respect to measures already taken on the askarel problem:

1 - That there are still, unquestionably, [illegible]tial number of users that have not been reached [illegible]s from Monsanto and transformer and capacitor manufacturers and from other publicity sponsored by Monsanto. Means for effectively reaching and educating employees of users of askarel-filled electrical equipment are also essential.

2 - That no guidelines are presently foreseen for such important areas as (a) disposal of askarel-soaked waste materials, (b) procedures for unloading and handling askarel and, (c) separation of askarel-soaked waste materials from other wastes.

3 - That foreign competitors of Monsanto, which is the sole domestic producer of askarel, must also be taken into account, in order for any program to be truly effective.

// CAMBELL A:

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Accordingly, the Monsanto Company and NEMA offer to assume leadership roles in an ANSI project aimed at solving the problem of disposition of askarel contaminated materials, and urge early consideration by ANSI of the recommendations set forth herein.

Very truly yours,

J. J. Kark
Engineering and Safety
Regulations Department

JJK:de

cc: C. A. Parris - BCP
A. M. Salazar - Div. 8
P. G. Benignus - Monsanto Co.
W. B. Papageorge - Monsanto Co.
W. C. Reinhardt - Moloney Electric Co.

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LECTURE GIVEN BY MR. MAY OF THE [illegible] AT A UNIVERSITY IN SWITZERLAND IN 1970

P.C.B. - USES IN ASKAREL FOR ELECTRICAL INDUSTRY

The name Askarel from the Greek "which does not burn", covers various dielectric fluids based on chlorinated diphenyls.

These liquids are at the present moment very largely used by the heavy electrical industry in the manufacture of transformer and capacitors.

We will now study the compounds and mixtures used in one and the other of these applications giving some details of their use.

We will finish this lecture by studying to what degree the heavy electrical industries may contribute to the chlorinated diphenyl pollution of the natural environment.

I - Use of chlorinated diphenyls in the capacitors -

The chlorinated diphenyls are used [illegible] for capacitors made of paper or plastic film. Their role consists in replacing the air in the porosity of the [illegible].

For this application, the trichlorodiphenyl is used mainly and this product contains on average three atoms of chlorine substituted on each molecule of diphenyl.

The chlorinated diphenyls were first used in nineteen thirty in the United States and now appear irreplaceable for this application.

EXHIBIT E

In effect, no other polar liquid having similar or neighbouring properties has yet been discovered to this time.

The capacitors are located either in square boxes of welded steel or in round or oval cans in aluminium.

In any case, the container must be water-tight, without which the humidity would penetrate into the apparatus and cause it to fail in use.

On the inside, the windings in paper, plastic film and aluminium are squeezed one against the other this taking up almost all of the space available.

After impregnation and filling of the rest of the empty space by the impregnating fluid, the water-tightness of the apparatus is effected by soldering.

2- Use of chlorinated diphenyls for transformers -

In this case, the Askarels are used as [illegible] fluids.

The winding and the magnetic circuits [illegible] are in effect completely immerged in a [illegible]

In this instance, the main characteristic of the Askarel is its property of non-flammability.

An Askarel transformer will not burn, nor explode in the case of an internal short circuit.

To this effect, mixtures of chlorinated diphenyls and chlorinated benzenes are employed. The mixture the most used being a blend of trichlorobenzenes (forty per cent) and hexa-chlorinated diphenyls sixty percent).

Contrary to the chlorinated diphenyls for capacitors, for which the technical performance are such that they are the only fluid used, the Askarels used in transformers compete in the same market with mineral oils. Economical and safety reasons guide the choice of the end-user.

Every time that it is necessary to set up a transformer in a public place (departmental store, theatre, cinema, etc..), in other words, when the fire risk must be contained, the choice nearly always falls on Askarel.

The Askarel transformer is likewise chosen when the end-user does not wish to be obliged to periodically verify the state of the dielectric fluid, as is the case for mineral oil transformers.

In effect, the Askarels used for transformers, capacitors, are characterized by a high chemical stability.

Contained in water-tight metallic receptacles, they last as long as the transformer.

Accidents caused by short-circuits in the interior of the transformer are the exception, an exception which we will talk about in a few minutes.

It should be interesting for the present conference to discuss the use of Askarel in Sweden.

To the best of our knowledge the only dielectric market is the capacitor market.

Sweden possesses, as you probably already know, one of the biggest constructors of power capacitors in Europe : Liljeholmens Kabel Fabrik.

Like the other manufacturers of capacitors in the world, this company uses trichlorodiphenyl, which Prodelec supplies under the name of Pyralene 1499.

As far as we know, the use of Askarel for transformers in Sweden is low.

We have seen that the main part of the Swedish consumption of Askarel concerns trichlorinated diphenyls.

This statement might be found surprising when one considers that it is especially the penta, hexa, and [illegible] nated diphenyls which have been found in Sweden's surrounding.

At this point, it is advisable to recall that this lecture is limited to the dielectric applications of chlorinated diphenyls because Prodelec is only concerned with these applications.

The fact that the trichlorinated diphenyls are not found in the natural environment may be explained as follows :

- they are exclusively used by the capacitor industry and hence hermetically closed from outside contact.

The dielectrical quality necessitates on the part of the manufacturer very special treatment and cares. The Askarels are, therefore, expensive products and any losses, if there are any, are always reduced to a bare minimum for obvious economical reasons.

Last of all, they are used by a small number of very large companies, having -and this is particularly true for Sweden - a very pronounced sense of their moral responsability concerning pollution, as you will be able to notice shortly.

This being said, we must consider if it is possible to eliminate any pollution due to the use of chlorinated dip[illegible] in the electrical industry.

This leads us to look out for and t[illegible] sources of pollution.

1°- Case of transformers :

The manufacturer delivers the main part of its Askarel production for transformers to a very limited number of end-users. The deliveries are made mainly by road tankers or rail tankers which are used only for the transportation of Askarels.

The contamination risks by impurities, which are likely to spoil the dielectric qualities of the Askarel, force the manufacturer to use closed tankers for his deliveries, these tankers never being used to transport any other material. Because of this, there is no systematic pollution risk due to packing or transport.

For those small quantities delivered in drums, the high fluidity of the product greatly limits any traces that may rest on the inside of the drums.

During the manufacture of the transformer, there is no loss whatsoever.

Let us now examine the case of those transformers, which after working for some time, have for various reasons broken down.

The Askarel is contaminated by the decomposition resulting from an electric arc : carbon and hy
It cannot be reused without regeneration bef
It is important to note that regenerating th
always possible.

Without having exactly the same characteristics as a new material, the regenerated Askarel for transformers offers the same garanties for use.

The only case for which regeneration is impossible is that when an Askarel is accidentally contaminated by mineral oil.

In effect, mineral oil cannot be separated from Askarels. Bearing in mind that a litter of transformer Askarel is generally speaking five times more expensive than mineral oil, the owner of a transformer has obviously every economic interest to obtain, either from the manufacturer, or from a specialized company, the reclamation of his contaminated Askarel.

For this reason, we have regenerated marge quantities of Pyralene for transformers in our factory.

The small fraction left unclaimed is burnt in our factory in a plant specially adapted for the disposal of liquid waste by combustion.

For this purpose, the Askarels are mixted with other flammable wastes in such a way that the mixture has a calorific value greater than five thousand Kilocalories - this value being determined previously in the laboratory. The temperature of the mixture of the combustion gases is raised up to eight hundred degrees centigrade. We have verified that these gases do not contain any trace of chlorinated diphenyls. But on the other hand, they do contain hydrochloric acid, the product of decomposition by pyrolysis.

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(7) EXHIBIT E

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The combustion gases are washed and then neutralized. In conclusion, for the case of Askarels in transformers, the end-users are pushed for technical and economical reasons to avoid any form of disposal of this material in the environment.

2°- Case of the capacitor industry :

It is useful to remember that this industry has, on first sight, no responsability for the pollution presently observed, since the trichlorodiphenyl which it uses, is not found in nature.

Nethertheless, some trichlorinated diphenyls, even limited to small quantities, might be dumped in the environment if certain measures and precautions are not taken.

The pollution risks begin with the delivery which is still carried out quite often by non-returnable in
biggest end-users, like Liljeholmens in Swe
with containers.

These containers are used for this purpose ever
again between the producing factory and that of the user.

This form of transport in container should become more general in future.

This should be all the more easy, since the contamination risks of the dielectric fluid from the inside walls of packing are eliminated in this way.

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Then we have to consider the waste when the capacitor itself is made.

The recipients containing the windings are filled under vacuum, either individually by way of an appropriate canalization, or by immersion of the apparatus in the impregnant.

During this operation the Askarel has,however, lost some of its dielectric properties. It must, therefore, either be returned to the Askarel manufacturer for reclaiming, as some of our customers do, or be regenerated at the factory by circulation of the Askarel in columns containing absorbing earth. Periodically, the packing of these columns must be changed. The capacitor manufacturer then has to dispose of this earth, wetted with trichlorinated diphenyls.

At the present time, this is generally [illegible] tipping. Although this solution is not probable, however, more efficient than, it would appear, the very low solubility or trichlorinated diphenyls in water.

As a last possible source of pollution, we have those capacitors which breakdown either in the factory during the dielectric testing or during their working period.

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These capacitors must be opened, the little amount of free impregnating fluid that they contain, collected and stored in drums to be returned for destruction at the producing factory.

Liljeholmens does this by returning to us at his own cost the waste material from the impregnating fluid and pays for the destruction of that which cannot be reclaimed.

This practice can and must be generalised in the years to come, bearing in mind the limited number of producers.

As far as the elements left from the brokendown capacitors are concerned, they may be ripped apart by a special machine and burnt in a rotating kiln, adapted to burn solid wastes. Such kilns can likewise be used to de troy the absorbing earth, thus offering a definite solution.

We have now seen that the chlorinated diphenyl [illegible] by the electrical industry are contained in closed systems and that the losses, during the manufacturing and use cycle have always been low in the past and can still be reduced in the future to insignificant values.