



# **INTRODUCTION: WHAT ARE PCBs?**



**PCB**  
PLATFORM



care  
and  
grooming  
of  
**ASKAREL**  
TRANSFORMER  
fluid

Monsanto

... to help you be sure your Askarel liquid insulation is tip-top and to keep it in the best of operating health

YOUR "ASKAREL" TRANSFORMER SHOULD BE

(AS FAR AS EQUIPMENT CAN BE!)

your  
best friend!

Since "askarel" type transformers were first made in 1930, few pieces of electrical equipment have equalled these "juice controllers" in trouble-free service. The name "askarel" applies to the liquid insulation that fills askarel type transformers. And "askarel" is a general name for a unique kind of chemical classified as a halogenated hydrocarbon. But, don't let this chemical jargon bother you one bit. After you read this little pamphlet, you'll be an EXPERT on operating askarel transformers; you'll know all about this wonderful liquid — askarel insulation — because it's all very simple.

however!

Since many engineers and maintenance operators work with BOTH askarel and transformer "oils," you will want to remember that askarel is *different* from mineral oil . . . and you'll want to know the simple ways to "check up" on the health of your askarel transformer.

That's the reason for this pamphlet. First, to tell you that your askarel transformer, in addition to being **FIRESAFE**, can be the most trouble-free piece of equipment you operate. Second, to give you the few simple facts that will make you an expert on the "whys" and "wherefores" of the easy maintenance. Knowing the facts given on the following pages, you will keep your askarel (and transformer) operating at trouble-free, top performance, year, after year, after year.\*

*\*We own one that has been operating as faithfully as a heart beat for 28 years!*

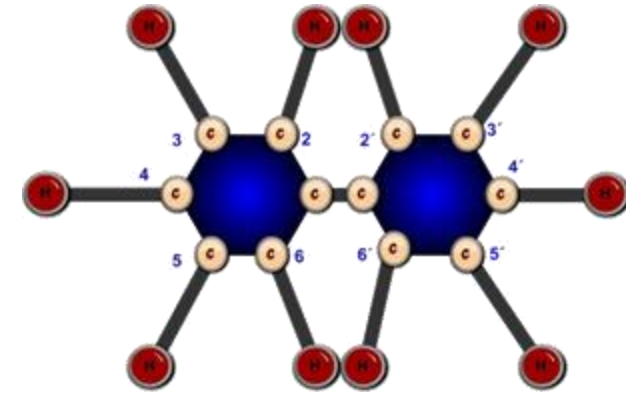
# What are PCBs?

Polychlorinated Biphenyls (PCBs) are a group of man-made organic chemicals consisting of carbon, hydrogen and chlorine atoms. The number of chlorine atoms and their location in a PCB molecule determine many of its physical and chemical properties.

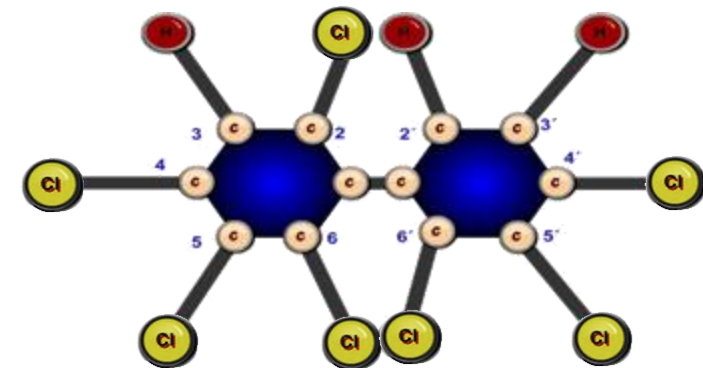


# Chemical Structure of the PCBs

- Basic structure are biphenyls
- For PCBs: 1-10 hydrogen atoms can be substituted by chlorine atoms
  - 209 PCB isomers and congeners with different numbers and positions of chlorine atoms exist
  - General formula:  $C_{12}H_{10-n}Cl_n$



Biphenyl:  $C_{12}H_{10}$



Heptachlorobiphenyl:  $C_{12}H_3Cl_7$

# PCB Nomenclature categories

Category	Number of individual Compounds	Definition
Congeners	209	The number of compounds with similar formula and similar properties.
Homologs	10	The number of chlorine atoms replaced.
Isomers groups	1-46	The number of compounds with the same formula, but different structure.

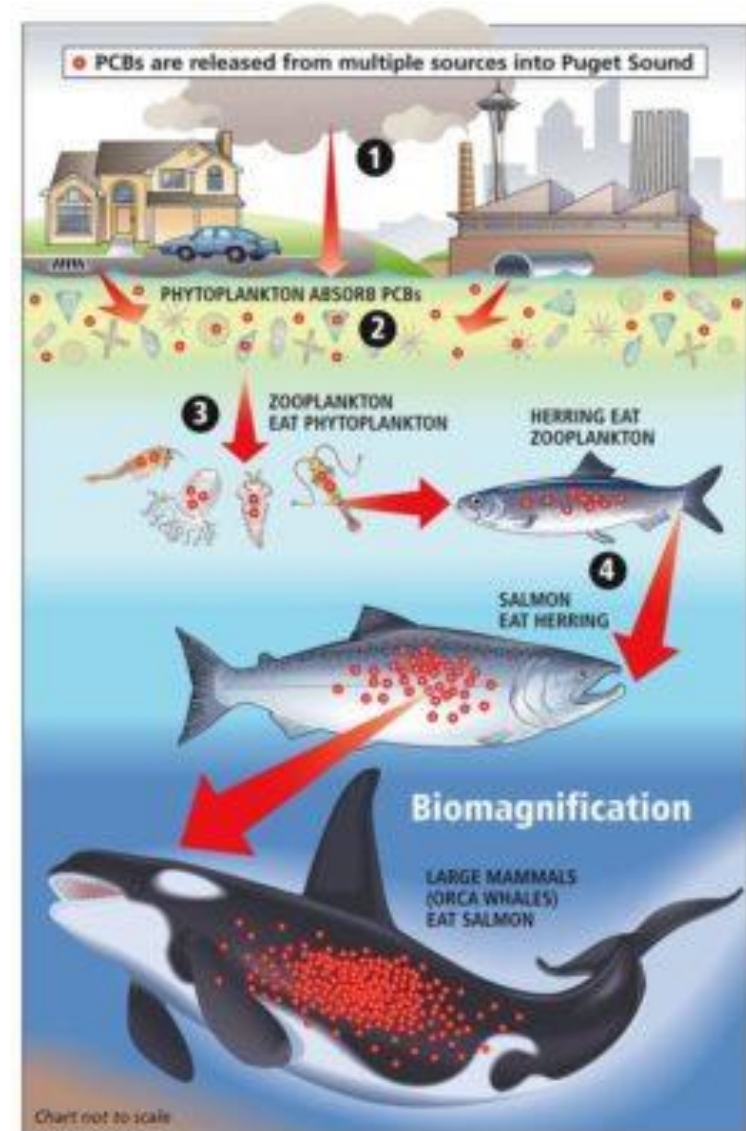
**130 Congeners were used in commercial products**

# PCB are Persistent Organic Pollutants

Persistent Organic Pollutants (POPs) are carbon-based chemicals which are characterized by:

- Persistency to degradation
- Long range transport
- Bioaccumulation in biota and miscibility with organic compounds
- Toxic to humans and environment

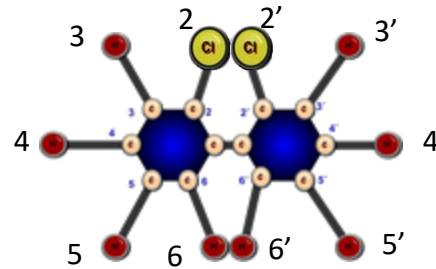
PCB are categorized as POPs by the Stockholm Convention!



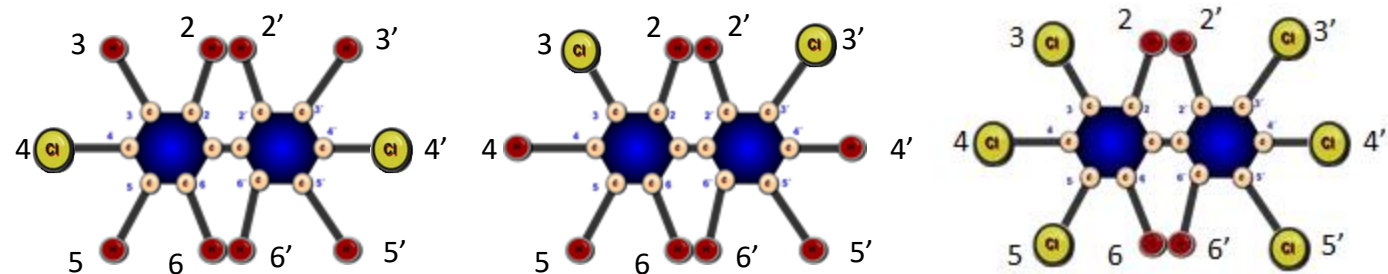
# Toxicity of the PCBs

Toxicity of PCB is dependent not only upon the number of chlorines present on the biphenyl structures, but also the positions of the chlorines. Chlorines in both para positions (4 and 4') and at least 2 chlorines at the meta positions (3, 5, 3', 5') are “dioxin like” and are particularly toxic.

Less toxic PCB molecule



More toxic PCB molecule



# Effects on human health



PCBs can:

- increase risk of **cancer**
- interfere with the **hormone system**
- lead to failure of **reproduction**
- suppress the **immune system**



# Characteristics of the PCBs

Parameter	Characteristic
Physical state	Liquid
Density	1.182 – 1.566 g/mL
Solubility in water	Low, $1.08 \times 10^{-5}$ - $9.69 \times 10^{-10}$ mol/liter
Solubility in oil and organic solvents	High
Solubility in lipids	Rapidly absorbed by adipose tissue.
Partition coefficient log Kow	4.46 – 8.18
Flash point	170 – 380 °C
Vapor pressure	Semi volatile
Henry's Law Constant (20 congeners)	$0.3 \times 10^{-4}$ – $8.97 \times 10^{-4}$ atm m <sup>3</sup> /mol at 25°C
Dielectric constant	High (low electrical conductivity)
Thermal stability	High fire resistance with high inflammability temperature
Chemical stability	High chemical stability
Impurities in commercial mixtures	Chlorinated dibenzofurans, chlorinated naphthalene, and chlorinated quaterphenyls.
Color	Yellow or colorless

# Common commercial PCB mixtures



Trade Name: **Aroclor**  
Company: **Monsanto Industrial Chemical Company**



Trade Name: **Clophen**  
Company: **Bayer**



Trade Name: **Phenoclor and Pyralene**  
Company: **Caffaro**



Trade Name: **Kanechlor**  
Company: **Kamegafuchi Chemical Company**



Trade Name: **Fenclor**  
Company: **Prodelec**



Company: **Chemko**



Company: **Cros SA**

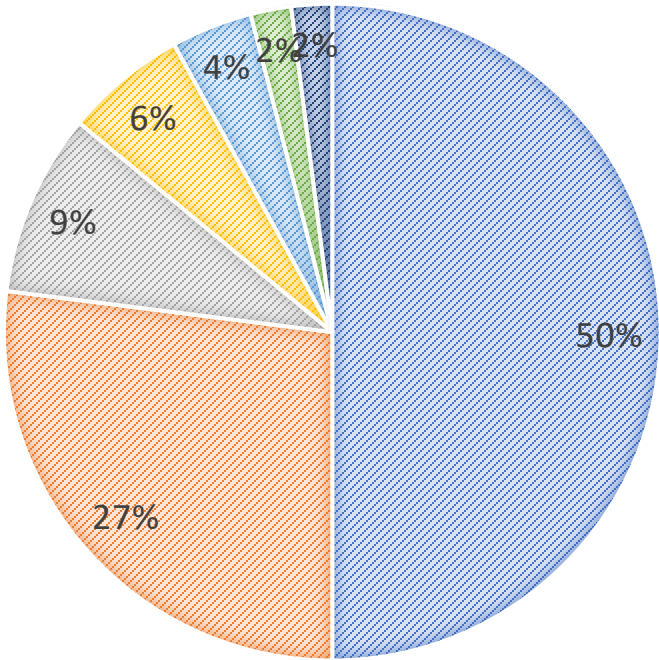
# Production of PCBs (1930 – 1982)

Company	Country	Production of PCBs (kMT)
Monsanto Industrial Chemical Company	USA/UK	475.7 / 66.6
Bayer	Germany	144.9
Caffaro	Italy	26.0
Kamegafuchi Chemical Company	Japan	59.1
Prodelec	France	101.6
Chemko	Czechoslovakia	21.5
Cros SA	Spain	27.5
TOTAL		923.0

Source: Ivan Holoubek, Polychlorinated Biphenyl (PCB) Contaminated Sites Worldwide – RECETOX-TOCOEN Associates, Veslarska 230B, 637 00 Brno, Czech Republic

# Use of PCBs (1929 – 1975)

- Capacitor
- Plasticizers
- Copy paper (carbonless)
- Hydrocarbon additives
- Transformers
- Hydraulic fluids and lubricants
- Heat transfer fluids



Ref: EPA, 1/30/97

# Applications

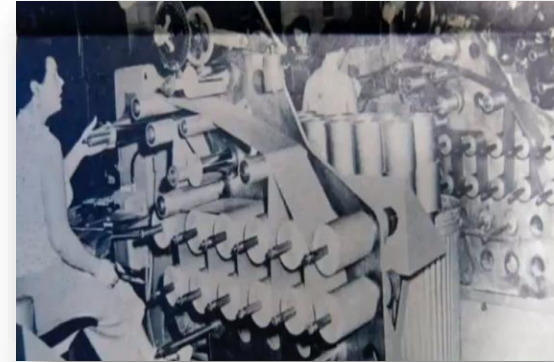
PCB have been used in a wide range of application due to their unique properties. Two categories of application can be identified:

Closed



PCB used in closed applications can be recovery and disposed of.

Open



PCB used in applications are difficult to recover. And maybe be released during every step of the lifecycle.

# Closed applications



Transformers  
(Aroclors A-1242, A-1254 A-1260)



Capacitors voltage transformers  
(Aroclors A-1242, A-1254 A-1260)



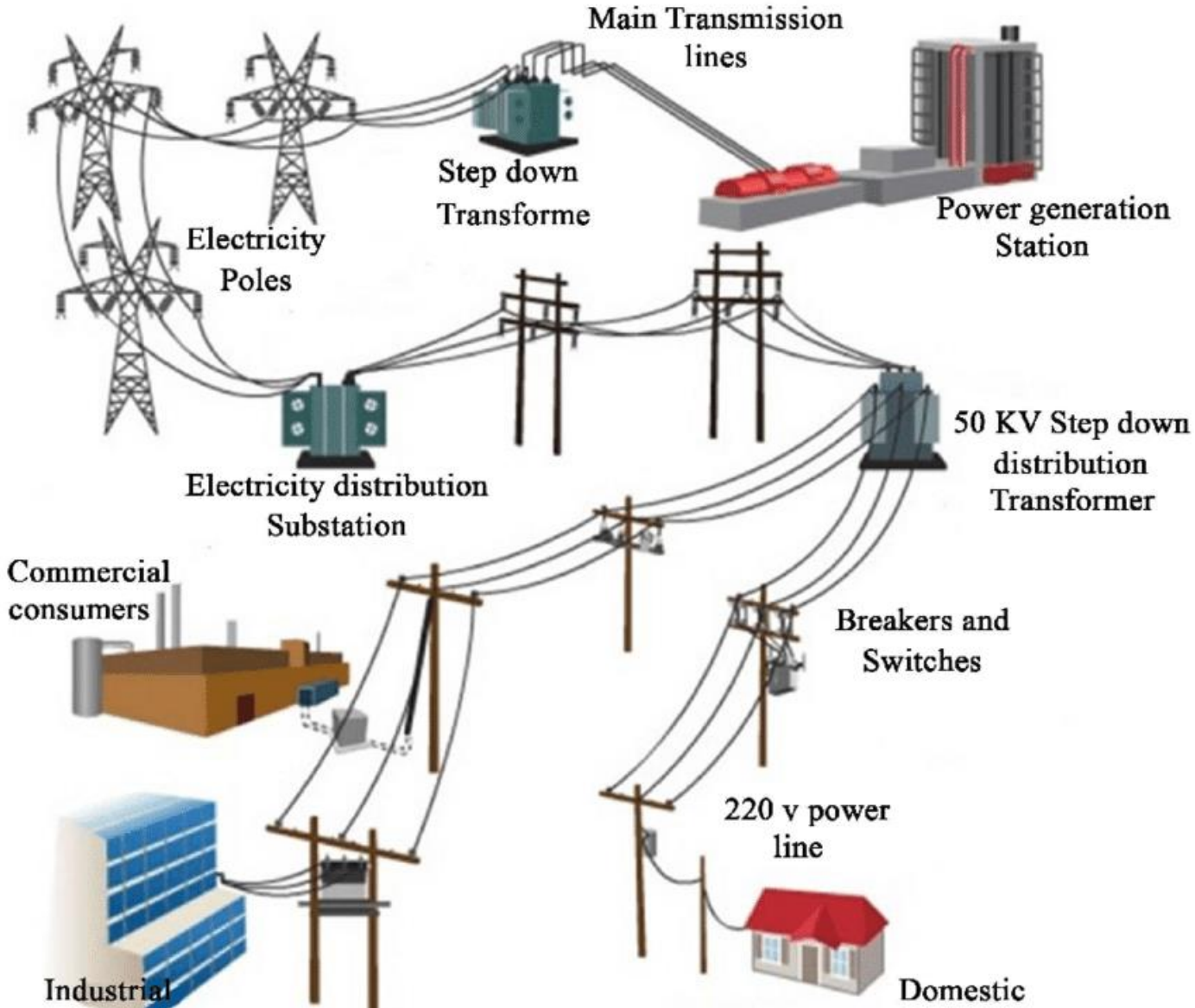
Capacitors  
(Aroclors A-1016, A-1221, A-1254)

Electrical equipment including voltage regulators, switches, re-closers, bushings, and electromagnets (Aroclors A-1242, A-1254 A-1260)

## Closed applications

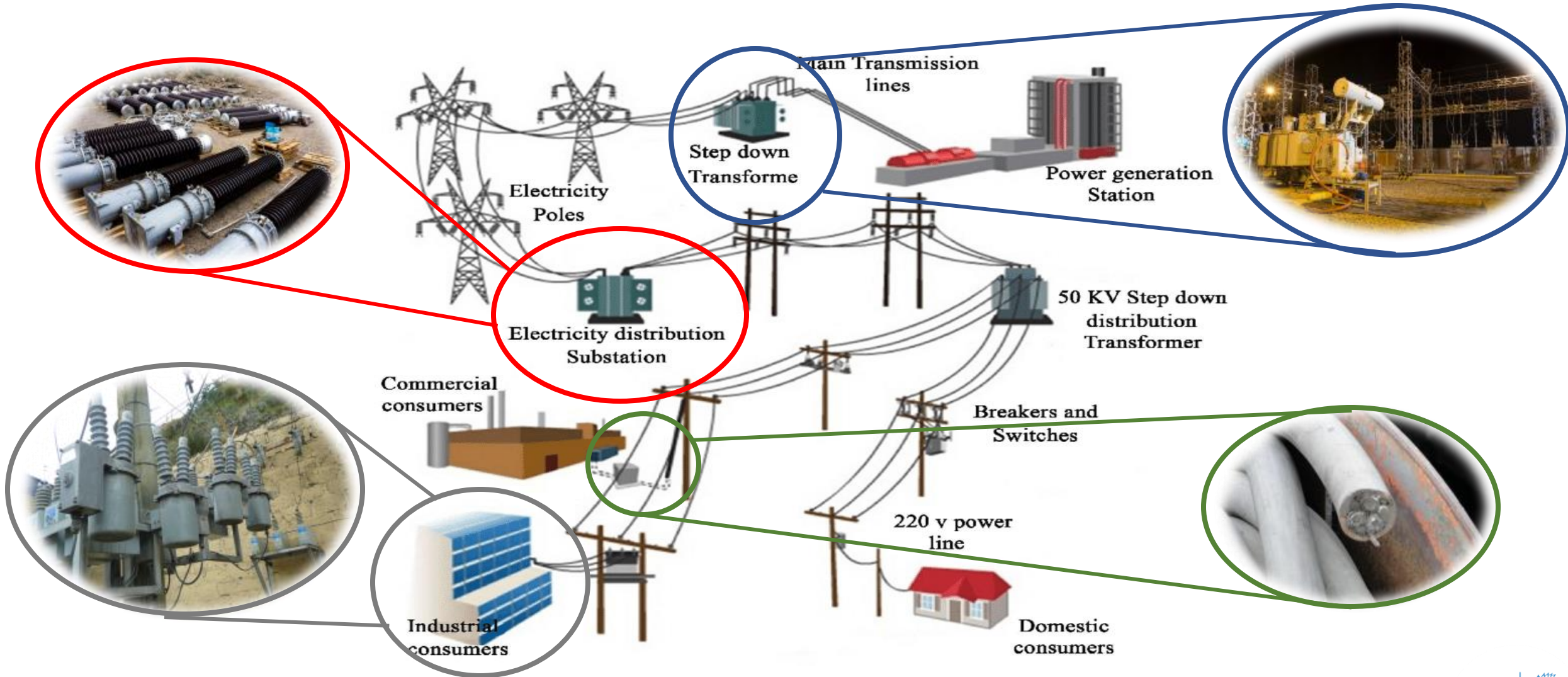
PCBs used as dielectrics in transformers and capacitors have a life equal to that of the equipment, and with proper design leakage does not occur. When the equipment is scrapped the quantity of dielectric is sufficiently large to justify treatment or final disposition.

# Electricity generation, transmission and distribution

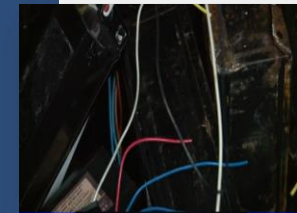
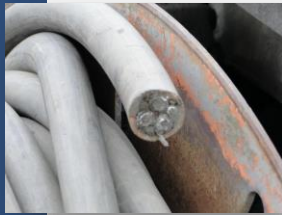




# Equipment that can contain PCB



# Other closed applications

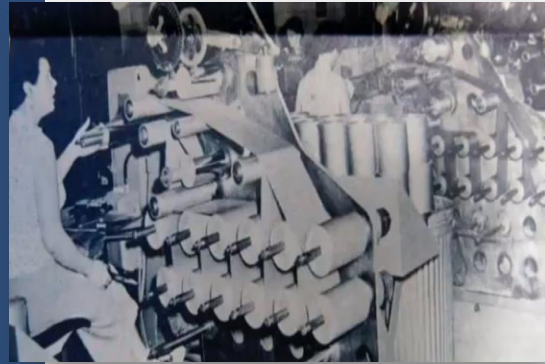


- Heat transfer fluids (Aroclors A-1242)
- Hydraulic fluids (Aroclors A-1232, A-1242, A-1248, A-1254, A-1260)
- Old electrical devices or appliances containing PCB capacitors (Aroclors A-1242, A-1254 A-1260)
- Fluorescent light ballasts (Aroclors A-1242, A-1254 A-1260)
- Cable insulation (Aroclors A-1242, A-1254 A-1260)

# Challenges with closed applications

PCBs were used in heat transfer and hydraulic systems which, although quite a replacement of small quantities makes recovery impractical. PCBs are very widely dispersed in small capacitors, and there are great difficulties in collecting these items for disposal not only in electrical utilities as well as production industries.

# Open applications

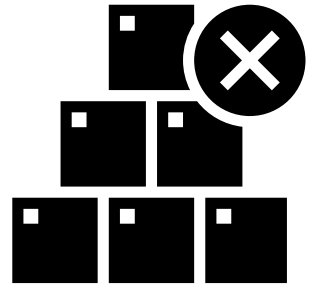


- Lubricating and cutting oils (Aroclors A-1254)
- Pesticides (Aroclors A-1254)
- Plasticizers in paints (Aroclors A-1221, A-1248, A-1254, A-1260, A-1262)
- Copying paper (Aroclors A-1242)
- Adhesives (Aroclors A-1232, A-1262)
- Sealants (Aroclors A-1254)



- Plastics (Aroclors A-1221, A-1262)
- Thermal insulation material including fiberglass, felt, foam, and cork (Aroclors A-1262)
- Floor finish (Aroclors A-1262, A-1268)
- Epoxy resins (Aroclors A-1221, A-1248, A-1262)
- Inks (Aroclors A-1254)

# Sources of contamination from closed applications



Inadequate storage places.



Bad practices in equipment manufacturing and maintenance (cross-contamination)

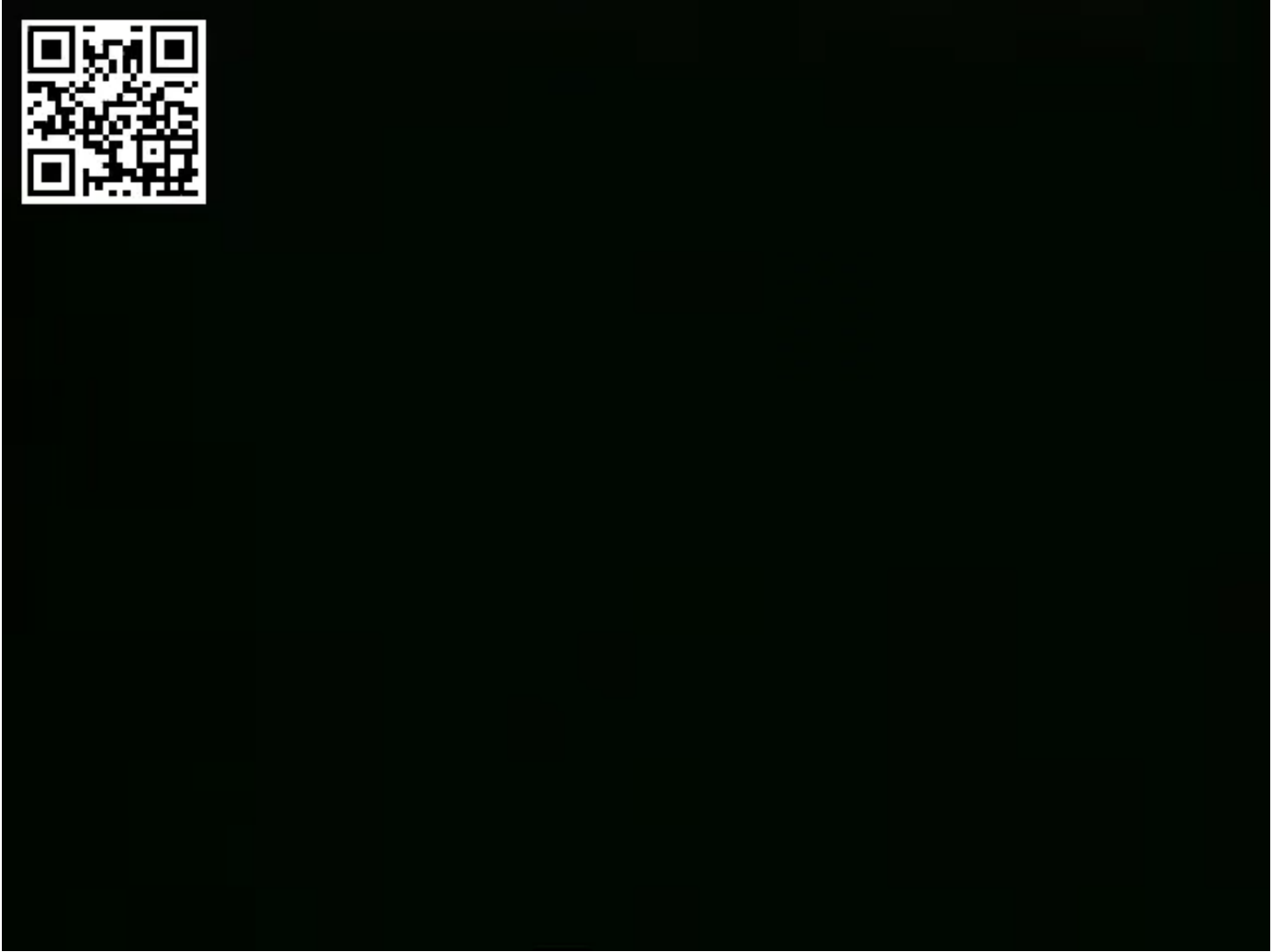
# Example of source contamination from transformers



# Cross - Contamination



# PCBs and the Stockholm Convention







**Thank you !**

<https://www.pcb.unitar.org/>

