

Methodology for Predicting PCB Concentrations in Transformers

A circular logo with a blue and green gradient background. It features a stylized globe with glowing blue lines and dots. A white horizontal band across the center contains the text "ENERGY DELIVERY AND CUSTOMER SOLUTIONS" in blue, sans-serif capital letters.

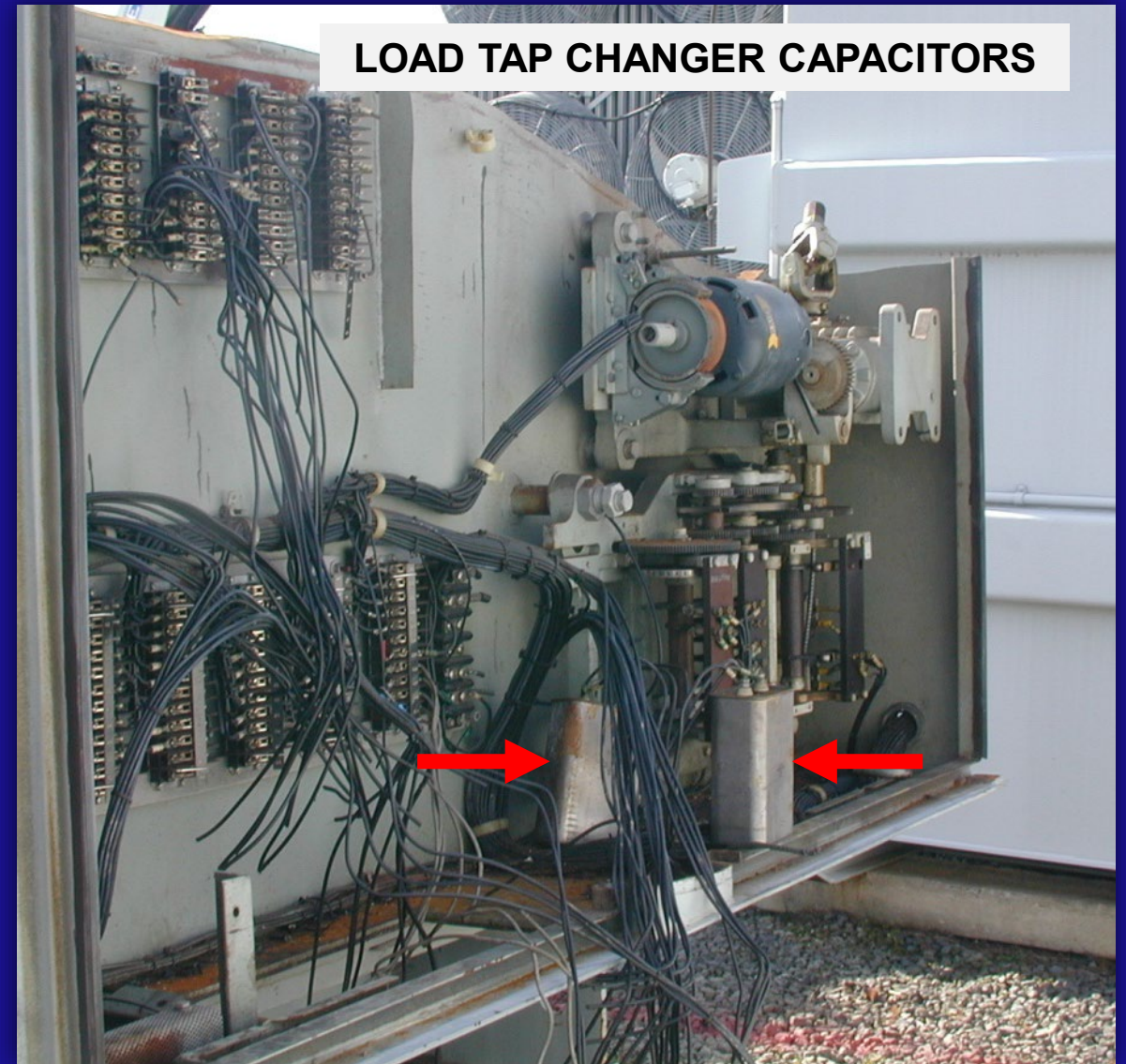
ENERGY DELIVERY
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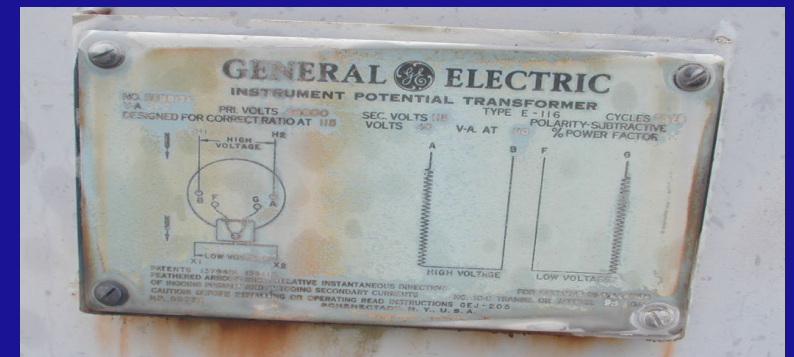
PCBs Are a Lingering Concern

- PCBs are still present in many locations throughout the US electrical grid
- Some aspects of new rule effective February 26, 2024 may have benefits for remediation
- Proactive identification and removal potentially reduce risk
- Which transformers or equipment, where?



Identifying PCBs in Electrical Equipment: Common Challenges

- Proactive, voluntary identification and removal can be challenging
- Lack of historical records
- Difficult or impossible to test in-service equipment
- Inability to test stored equipment without damage
- EPRI worked for many years to develop a database and method to assist utilities with identification and prioritization



EPRI's PCB Database

- In 2010, EPRI gathered information on PCB transformers from across the industry
- Historical data, internal studies, company databases, PCB annual document logs, and test results
- Serial number code sheets collected from 31 manufacturers
- Over 345,000 data points from 133 different manufacturers for equipment dating back to 1930s



Expanding the Usefulness of Available Data



- EPA and EPRI have databases of transformers known to contain PCBs
- While useful, doesn't help with transformers not in the databases
- To utilize the available information a statistical method was developed with Exelon to assess the probability of a unit containing PCBs based on information for "sister" units
- Manufacturer, production date, facility, and/or serial number used to aid in evaluation

Curating the Database

- With development of statistical analysis, EPRI's database was curated and assessed
 - Data points most likely to be useful for analysis
 - Exclusion of points not meeting minimum requirements
 - Exclusion of post-1978 manufacture date equipment
- Assessment of code sheets and serial number patterns in the data
- Summarized in EPRI report [Predicting the Potential Polychlorinated Biphenyl Concentration \(PCB\) in Electrical Equipment](#)



EPRI PCB Database Assessment Results

- General distribution of PCB results by manufacturer

Standard Manufacturer	Equipment Type	Equipment Sub Type	Number of Records	% >50 ppm	% >500 ppm	Report Data Location
4-Way	Transformer	Padmount	1	0.0	0.0	Appendix C
AB Chance	Transformer	Transformer	998	4.5	0.0	Appendix B
Allis Chalmers	Bushing	Bushing	15	13.3	0.0	Appendix D
ATSCO	Transformer	Transformer	6	100	50.0	Appendix C
Central Moloney	Transformer	Polemount	22,476	1.2	0.0	Appendix B
General Electric	Transformer	Padmount	3002	10.4	2.4	Appendix B
Kyle	Regulator	Regulator	3	0.0	0.0	Appendix D
Solabasic	Misc. equip	Misc. equip	2	0.0	0.0	Appendix D
Standard Transformer	Transformer	Transformer	84	23.8	1.3	Appendix B
Van Tran Electric	Transformer	Transformer	11	100	18.2	Appendix C

Sister Unit Analysis: Considerations and Limitations



- Based on information in EPRI's database and the development of the statistical method, certain locations and years of manufacture are more likely to contain PCBs
- This is a *predictive* method, and does not provide *actual* concentration – not intended to meet regulatory reporting requirements
- Limited to distribution transformers based on records in database
- Does not address status of retrofilled transformers beyond possible original PCB concentration



Cobra style street light capacitor
with oil-impregnated paper

Sister Unit Analysis

- The serial number of the transformer plus location and date of manufacture (if known) can be used to predict the likelihood of a certain unit containing PCBs
- The closer the serial numbers most proximate to that of the transformer under evaluation, the more robust the analysis result
- Serial numbers within 50 are considered close match, while those >1001 may not be as indicative of PCB status

EPRI Database Closest Sister Unit Proximity Code	EPRI Database Closest Sister Unit PCB (ppm)
A	95
A	300
B	2
B	29
B	0
B	7
B	0
B	4
B	1
C	6
C	0
C	25
C	21
C	5

Proximity Code

A = 1 - 50

B = 51 - 100

C = 101 - 250

D = 251 - 500

E = 501 - 1000

F = >1001

User-Performed Sister Unit Analysis

- Sister unit analyses can be performed on single transformer or batches of transformers
- Can be performed by utility personnel or as a supplemental project with EPRI (e.g., for large batches of data or data with significant gaps)

<https://pcbdb.epri.com/>

The screenshot shows the top portion of the EPRI PCB Contamination Database website. At the top right, there are links for "Log Out", "Calendar", and "EPRI.com". The EPRI logo and "ELECTRIC POWER RESEARCH INSTITUTE" are on the left. A navigation bar contains "Home", "About", and "Help". The main header area is titled "Oil-Filled Equipment PCB Contamination Database". Below this, a section titled "Is the Oil in Your Distribution Transformer Contaminated?" provides a brief description and two options: "Use a seven-step input form for an individual transformer." and "Upload a spreadsheet for a batch of transformers.", each with a "Go" button. The footer contains links for "Careers", "Contact EPRI", "Copyright Policy", "Privacy Statement", and "Terms of Use", along with contact information and a copyright notice for 2001-2024.

User-Performed Sister Unit Analysis

- The manufacturer name and year are the most useful information for the analysis, followed by serial number
- Equipment type and manufacturer are required inputs

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Oil-Filled Equipment
PCB Contamination Database

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Is the Oil in Your Distribution Transformer Contaminated?

Discover whether the oil in your distribution system transformer may be contaminated with PCBs using the seven steps shown below.

Step 1. What is the TYPE of the transformer? (**REQUIRED**)

Step 2. What is the MANUFACTURER of the transformer? (**REQUIRED**)

Step 3. What is the POWER RATING of the transformer in kVA (**OPTIONAL**, numbers only)?
 kVA

Step 4. What is the YEAR of manufacture (**OPTIONAL**, four-digit years only)?

Step 5. Select YEAR WINDOW for matching (**OPTIONAL**, only when YEAR or SERIAL NUMBER is provided)?

Step 6. What is the SERIAL NUMBER of the transformer (**OPTIONAL** unless box below is checked)?
 Find Year and Plant of Manufacture by Serial Number

Step 7. Submit your information.

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User-Performed Sister Unit Analysis - Output

Results of Your Search



Information about Your Transformer

- :: Your Transformer Type: AllTransformers
- :: Manufacturer: WH
- :: Power Rating: No Power Rating Provided
- :: Year of Manufacture: 1967
- :: Serial Number: No Serial Number Provided

[:: How To Interpret Your Results](#)

[Back To Search Page](#)

Descriptive Statistics for Similar AllTransformers in the Database

- :: Range of Years of Manufacture: 1966 to 1968
- :: Number of records matching your search criteria: 3,010
- :: Total number of records with a PCB level equal to or greater than 50 ppm: 935 ←
- :: Percent of records with a PCB level equal to or greater than 50 ppm: 31.06% ←
- :: Total number of records with a PCB level equal to or greater than 500 ppm: 86 ←
- :: Percent of records with a PCB level equal to or greater than 500 ppm: 2.86% ←
- :: Highest PCB level of returned records: 1,606.00 ppm ←

User-Performed Sister Unit Analysis - Output

:: Plant locations: ATHENS, SHARON, UNKNOWN 

:: Number of transformers made in ATHENS: 1,859
:: Total number of records with a PCB level equal to or greater than 50 ppm: 28
:: Percent of records with a PCB level equal to or greater than 50 ppm: 1.51%
:: Total number of records with a PCB level equal to or greater than 500 ppm: 0
:: Percent of records with a PCB level equal to or greater than 500 ppm: 0%
:: Highest PCB level of returned records: 313.00 ppm

:: Number of transformers made in SHARON: 1,127
:: Total number of records with a PCB level equal to or greater than 50 ppm: 891
:: Percent of records with a PCB level equal to or greater than 50 ppm: 79.06%
:: Total number of records with a PCB level equal to or greater than 500 ppm: 81
:: Percent of records with a PCB level equal to or greater than 500 ppm: 7.19%
:: Highest PCB level of returned records: 1,606.00 ppm

:: Number of transformers made in UNKNOWN: 24
:: Total number of records with a PCB level equal to or greater than 50 ppm: 16
:: Percent of records with a PCB level equal to or greater than 50 ppm: 66.67%
:: Total number of records with a PCB level equal to or greater than 500 ppm: 5
:: Percent of records with a PCB level equal to or greater than 500 ppm: 20.83%
:: Highest PCB level of returned records: 956.00 ppm

Sister Unit Analysis – Results Interpretation

Search

How To Interpret Your Results

The results of a search are intended for general guidance only. The Oil-Filled Equipment PCB Contamination Database contains a small sample of the entire population of transformers that use oil as an insulator and coolant. The degree to which the sample represents the entire population is not known. However, the results provided can be used to determine the likelihood of contamination of a given transformer for a given set of search criteria.

Range of Years of Manufacture. The years during which matching transformers were manufactured.

Number of records matching your search criteria. The number of records returned from the dataset that match the criteria entered by the user.

Total number of records with a PCB level equal to or greater than 50 ppm. The number of records returned from the dataset that meet the search criteria where the concentration level of PCBs in the oil sample were equal to or greater than 50 parts per million (ppm).

Percent of records with a PCB level equal to or greater than 50 ppm. The percentage of records returned from the dataset that meet the search criteria where the concentration level of PCBs in the oil sample were equal to or greater than 50 parts per million (ppm).

Total number of records with a PCB level equal to or greater than 500 ppm. The number of records returned from the dataset that meet the search criteria where the concentration level of PCBs in the oil sample were equal to or greater than 500 parts per million (ppm).

Percent of records with a PCB level equal to or greater than 500 ppm. The percentage of records returned from the dataset that meet the search criteria where the concentration level of PCBs in the oil sample were equal to or greater than 500 parts per million (ppm).

Highest PCB level of returned records. The highest level of PCB contamination measured in all of the transformers in the returned records.


A Note About PCB Contamination in Transformers Manufactured Before 1929

PCBs were first synthesized in 1881 but were developed and used commercially from about 1929 until 1977. Manufacturing was halted in 1977 due to concerns about widespread environmental contamination. Therefore, any PCB contamination of a transformer manufactured before 1929 was caused by refilling the transformer with contaminated oil sometime after 1929.

Close

User-Performed Batch Analysis

- Download formatted Excel spreadsheet for data entry – limit 99
- MUST have manufacturer information



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Oil-Filled Equipment

PCB Contamination Database

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Is the Oil in Your Distribution Transformer Contaminated?

You can use the PCB Excel spreadsheet to manually enter data (one row at a time or copy/paste from an existing spreadsheet). [Click here to download the spreadsheet.](#)

NOTE: Delete all unused rows from row 2 to row 100 before saving and submitting your Excel workbook. NOTE: If you copy and paste a long string of numbers into the UniqueID field, Excel may attempt to convert it to scientific notation. To prevent that conversion, enter an apostrophe (') into the field first, and then paste the string of numbers. The apostrophe will not be processed by the web application.

You can also use an existing spreadsheet in Excel format (*.xlsx) or CSV format (*.csv). The PCB Contamination Database will accept a spreadsheet with the following column names (the spreadsheet *must* have a header) in the following order:

Field Name	Type of Field and Acceptable Values	Mandatory/Optional
UniqueID	Internal tracking ID used by your company. It must be unique for each transformer. Length is limited to 40 alphanumeric characters.	Mandatory
TransformerType	Three transformer types are allowed from the pulldown list: Transformer (this includes all types), Padmount, or Polemount.	Mandatory
Manufacturer	Select from pulldown list in Excel template or type in for a CSV or text file. If not listed in the Excel template, the database has no matching records.	Mandatory
Location	City or State, from the label or manifest. Note that the values in the Location dropdown list are tied to the manufacturer selected to the left. Length is limited to 40 characters, composed of alphanumeric characters, spaces, and hyphens.	Optional
PowerRating	For limiting your search to a power class. PowerRating must be a positive number in kVA.	Optional
Year	Year manufactured (such as 1972). Must be a four-digit positive number. Limited data are available for after 1979—query results for later years may not be representative.	Optional
RangeOfYears	The three acceptable values are 1 (one-year window), 3 (three-year window), or 5 (five-year window).	Optional
SerialNumber	Transformer serial number. It must contain only numbers and letters (lower or upper case)	Optional
SerialMatch	Select "True" if you want to determine the year of manufacture (limited to certain manufacturers) based on the provided SerialNumber. This must be "True" or "False." If set to "True," a SerialNumber must also be entered.	Optional

Once you have a properly formatted spreadsheet, upload it for validation by clicking on the Browse button below, selecting your spreadsheet, and then clicking on the Validate Spreadsheet button.

Choose File No file chosen
Validate Spreadsheet
Cancel

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	A	B	C	D	E	F	G	H	I
	UniqueID	TransformerType	Manufacturer	Location	PowerRating	Year	RangeOfYears	SerialNumber	SerialMatch
1									
2		Transformer	AB Chance				1		False
3		Transformer	AB Chance				1		False
4		Transformer	AB Chance				1		False
5		Transformer	AB Chance				1		False
6		Transformer	AB Chance				1		False
7		Transformer	AB Chance				1		False
8		Transformer	AB Chance				1		False
9		Transformer	AB Chance				1		False
10		Transformer	AB Chance				1		False
11		Transformer	AB Chance				1		False
12		Transformer	AB Chance				1		False
13		Transformer	AB Chance				1		False
14		Transformer	AB Chance				1		False
15		Transformer	AB Chance				1		False
16		Transformer	AB Chance				1		False
17		Transformer	AB Chance				1		False
18		Transformer	AB Chance				1		False
19		Transformer	AB Chance				1		False
20		Transformer	AB Chance				1		False
21		Transformer	AB Chance				1		False
22		Transformer	AB Chance				1		False
23		Transformer	AB Chance				1		False
24		Transformer	AB Chance				1		False
25		Transformer	AB Chance				1		False
26		Transformer	AB Chance				1		False
27		Transformer	AB Chance				1		False
28		Transformer	AB Chance				1		False
29		Transformer	AB Chance				1		False
30		Transformer	AB Chance				1		False
31		Transformer	AB Chance				1		False
32		Transformer	AB Chance				1		False
33		Transformer	AB Chance				1		False
34		Transformer	AB Chance				1		False
35		Transformer	AB Chance				1		False
36		Transformer	AB Chance				1		False
37		Transformer	AB Chance				1		False
38		Transformer	AB Chance				1		False
39		Transformer	AB Chance				1		False
40		Transformer	AB Chance				1		False
41		Transformer	AB Chance				1		False
42		Transformer	AB Chance				1		False
43		Transformer	AB Chance				1		False
44		Transformer	AB Chance				1		False
45		Transformer	AB Chance				1		False
46		Transformer	AB Chance				1		False
47		Transformer	AB Chance				1		False
48		Transformer	AB Chance				1		False
49		Transformer	AB Chance				1		False

User-Performed Batch Analysis - Output

- Returns Excel file with information about each transformer
- The Unique ID field is your company's tracking number for the asset – part of the initial data entry

Unique ID	Total Records	Number ≥ 50 ppm	Percent ≥ 50 ppm	Number ≥ 500 ppm	Percent ≥ 500 ppm	Highest PCB Level (ppm)
1910E1	30638	7423	24.23	435	1.42	37195
A30825	150	7	4.67	0	0	366
1910F1	30625	7420	24.23	435	1.42	37195

EPRI-Performed Sister Unit Analysis

- Same information is required
- Can run batches of thousands rather than 99 units
- Can address most data gaps or errors

Orig Line #	Manufacturer	Serial Number	Original Mfg Date	EPRI Assigned Mfg Date	EPRI Assigned Manufacture Location	Number of Matching Units (1 year)	Percent of Matching Units ≥50 ppm	Percent of Matching Units ≥500 ppm	Maximum PCB Conc. in Matching Units (ppm)	Comments
2433	HEVI DUTY	15137215	1971	1971	Unknown	0	NA	NA	NA	No Match for Mfg. Year/Location in database
7869	RTE	1118164	1962	1961	Waukesha	21	0	0	13	
7876	MCGRAW EDISON	640682-1-1	1971	1963	Zanesville	0	NA	NA	NA	No Match for Mfg. Year/Location in database
7934	ALLIS CHALMERS	1749038	1964	1941	Pittsburgh	28	21.43	0	197	
7936	ALLIS CHALMERS	1749034	1964	1941	Pittsburgh	28	21.43	0	197	
7937	DELTA STAR	E59025	1970	1970	Lynchburg	39	7.69	0	131	
7938	ALLIS CHALMERS	1749033	1964	1941	Pittsburgh	28	21.43	0	197	
7939	GENERAL ELECTRIC	8417445	1959	1940	Pittsfield	247	61.54	12.15	8140	
7941	RTE	746006266	1975	1974	Waukesha	778	0.77	0	70	
7942	RTE	746006265	1975	1974	Waukesha	778	0.77	0	70	
7988	ALLIS CHALMERS	2337982	1967	1950	Pittsburgh	346	14.16	0	287	
7990	PENNSYLVANIA	0-00779-5-4	1967	1958	Cannonsburg	0	NA	NA	NA	Assumed Serial Number beginning with "C-00" for assignment o Year/Location in database.
8000	STANDARD	126253	1965	1955	Warren	0	NA	NA	NA	No Match for Mfg. Year/Location in database
8001	MOLONEY	1758958	1956	1956	St. Louis	372	5.11	0	240	
8015	WAGNER	9Y4471	1970	1968	Wellston	1863	55.82	6.33	1360	
8029	GENERAL ELECTRIC	H271366-70P	1976	1970	Pittsfield	98	8.16	0	248	
8030	WESTINGHOUSE	554411-1	1955	1955	Sharon	960	20.70	0.52	820	

EPRI-Performed Sister Unit Analysis

- Detailed information on sister unit proximity provided

Original Ro	Manufacturer	Serial Number	Original MFG Date	EPRI Assigned MFG Date	EPRI Assigned Manufacture Location	EPRI Database Closest Sister Unit Proximity Code	EPRI Database Closest Sister Unit PCB (ppm)	Notes
2433	HEVI DUTY	71G-187215-1	1971	1971	Unknown	NA	NA	No Sister Units in database for Mfg. Year.
7869	RTE	1118184	1962	1961	Waukesha	C	6	
7876	MCGRAW EDISON	C40882-1-1	1971	1963	Zanesville	C	0	
7934	ALLIS CHALMERS	1749036	1964	1941	Pittsburgh	D	189	
7936	ALLIS CHALMERS	1749034	1964	1941	Pittsburgh	D	189	
7937	DELTA STAR	E58025	1970	1970	Lynchburg	F	0	
7938	ALLIS CHALMERS	1749033	1964	1941	Pittsburgh	D	189	
7939	GENERAL ELECTRIC	6417445	1959	1940	Pittsfield	C	25	
7941	RTE	748006286	1975	1974	Waukesha	B	2	
7942	RTE	748006285	1975	1974	Waukesha	B	2	
7988	ALLIS CHALMERS	2337982	1967	1950	Pittsburgh	C	21	
7990	PENNSYLVANIA	0-00779-5-4	1967	1958	Canonsburg	D	0	Assumed Serial Number beginning with "C-00" for sister unit analysis.
8000	STANDARD	126253	1965	1955	Warren	F	5	Next closest sister unit (Proximity Code C) >50 ppm
8001	MOLONEY	1758658	1956	1956	St. Louis	C	5	
8015	WAGNER	8Y4471	1970	1968	Wellston	F	0	
8029	GENERAL ELECTRIC	H271366-70P	1976	1970	Pittsfield	C	13	
8030	MCGRAW EDISON	1758658	1956	1956	St. Louis	C	5	

SN Proximity Code
 A = 1 - 50
 B = 51 - 100
 C = 101 - 250
 D = 251 - 500
 E = 501 - 1000
 F = >1001

Applications for Sister Unit Analysis

- Identifying distribution transformers with the potential to contain PCBs at the time of manufacture
- Prioritizing removal and/or replacement of equipment
- Spill response prioritization during storm events



Additional EPRI Resources for PCBs

*EPRI Program 51 Transmission & Distribution Environmental Issues Product Index [3002028967](#)

Oil-Filled Equipment PCB Contamination Database (PCBDB), version 2.0 [3002010360](#)

*Methodology for Predicting PCB Concentrations Helps Prioritize Decisions About Early Removal of Transformers [3002007353](#)

*Polychlorinated Biphenyls (PCBs) in Electrical Equipment [3002007128](#)

*The PCB Information Manual, Volume I: Production, Uses, Characteristics, and Toxicity of PCBs, Second Edition [3002008537](#)

*The PCB Information Manual, Volume II: PCB Characterization, Sources, and Releases, Second Edition [3002026327](#)

*Polychlorinated Biphenyl Compounds in Used Transformer Fluids [3002000988](#)

*Predicting the Potential Polychlorinated Biphenyl Concentration in Electrical Equipment [2013748](#)

*Available at no cost



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