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Including PCB Cleanup Policy and Procedures

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Introduction

PCB and PCB Contaminated transformers and electrical equipment are still in service extensively throughout the United States. Owners of this equipment face well documented risks with regard to environmental protection. Continued use in service of this type of equipment and cleanup of any releases of fluid are highly regulated. Additionally, contaminated hydraulic and heat transfer systems are frequently encountered. Many times, the first indication that the owner has such a system is when it leaks and the resultant spill is analyzed prior to cleanup.

Because PCBs in electrical equipment and many other plant systems were used extensively for years without the types of controls that have been required since 1978, a large number of industrial facilities are contaminated by old PCB spills to varying degrees.

To regulate the continued use and disposal of PCBs, the United States Environmental Protection Agency (USEPA), under authority granted by the Toxic Substances Control Act (TSCA), promulgated and is charged with enforcing the regulations contained in Title 40 Code of Federal Regulations Part 761 (40 CFR 761). Particularly applicable to this paper are the requirements of Subpart G, PCB Cleanup Policy, which became effective on May 4, 1987. Based on conversations and presentations at a number of technical conferences, it is apparent that there is considerable confusion in industry regarding which spills and leaks are covered, how the USEPA mandates that spills and contamination be cleaned, and how PCB equipment and materials need to be disposed of..

The costs of complying with the inspection and record keeping requirements of 40 CFR 761 are considerable. Further, the risks of having to clean up of a spill or leak under the requirements of Subpart G are evident to most transformer owners. As a result, many industrial owners, who would otherwise be able to continue to operate PCB containing equipment, are removing and replacing the equipment.

This paper has two distinct, but related parts. First, the PCB Spill Cleanup policy will be reviewed. Second, methods of disposal available to owners will be discussed. Spill cleanup requirements are causing many owners to dispose of equipment as a method of eliminating PCB related risks.

Unfortunately, as the paper discusses, some methods of "legal" disposal, allowed under the regulations, do not eliminate risks, but may actual increase them. The paper offers an alternative that eliminates the long term exposure risks caused by disposal of PCB containing equipment. In particular, the paper presents a three step solution to this problem that depends on:

- Specifying an appropriate method of disposal to completely destroy PCBs.
- Utilizing vendors who are EPA approved and inspected.
- Reviewing thoroughly the control mechanisms and procedures used by vendors to prevent environmental exposures to PCBs and to ensure that the customers long term liabilities are completely eliminated.

PART I

PCB Cleanup Requirements

The USEPA Spill Cleanup Policy Rule was first published in the Federal Register, Volume 52, page 10705, et. seq., April 2, 1987 and is contained in 40 CFR 761, Subpart G. The policy establishes requirements for cleanup of spills and releases of materials containing PCBs concentration of 50 ppm and greater. Any spill or release of material contaminated by PCBs to a concentration of 50 ppm or greater is defined as an illegal disposal of PCBs.

Applications

The cleanup policy applies to spills which occur on or after May 4, 1987, i. e., fresh spills. Spills and releases known to be older than May 4, 1987, or spills that cannot be documented as to date are not subject to the policy. Instead, authority is given the EPA Regional Administrators to dictate methods of cleanup and final cleanliness levels. EPA did not include spills that existed as of the effective date of the regulation for two reasons:

- To avoid interference with EPA mandated cleanup efforts in force as of that date.
- To allow for a sufficient cleaning of older spills. USEPA has published the opinion that spills that have been allowed to sit for a long period of time would not be sufficiently remediated by the procedures published in the policy.

Also excluded from the policy are spills and releases directly into water, sewers, vegetable gardens and animal grazing lands. Because of the potential for contamination of food or water supplies, cleanup of these spills will be directed by the Regional Administrator.

The Regional Administrator is also given authority to require either more stringent or less stringent cleanup provided that the need for the variance in requirements can be documented.

Reporting Requirements

Spills of any amount of fluid, where the PCB concentration is over 50 ppm, that contaminate surface waters, sewers, drinking water supplies, vegetable gardens, or grazing lands must be reported to the USEPA Regional Office within 24 hours of discovery.

For all other spills, where more than 10 pounds of PCBs are spilled, the spill must be reported to the USEPA Regional Office within 24 hours of discovery.

For spills of 10 pounds or less of pure PCBs, notification of USEPA is not necessary but cleanup and decontamination must be performed in accordance with all other policy requirements as listed in 40 CFR 761.125.

The reporting and notification requirements are in addition to any other required notifications, including those that may be required under the Clean Water Act (CWA) or the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). In particular, the National Contingency Plan requires that all spills involving 10 pounds or more of PCBs must be reported to the National Response Center, (800)424-8802.

Cleanup Requirements

Spill cleanup requirements are categorized by the concentration and amount of PCBs spilled, together with where the material is spilled. Procedures and the results of the cleanup that must be documented further depend on the surfaces and materials that are contaminated and the access that the public has to these surfaces. Knowledge of the items dictates the final spill cleanup level. All wastes and debris resulting from a cleanup must be disposed of in accordance with the requirements for PCB disposal from 40 CFR 761.60.

The descriptions below are taken from Subpart G. The specific applicable sections of the regulations are §761.125, §761.130, and §761.135. The definitions are found in § 761.123. You should have a current copy of the regulation immediately available in the event that a spill or leak is discovered. The regulations are written so as to require a quick response.

"Low Concentration Spills"

Definition:

Material between 50 ppm and 500 ppm AND less than 1 pound total PCBs spilled or released.

NOTE:

270 gallons of mineral oil at 500 ppm contains one pound of PCBs. Until the untested mineral oil dielectric fluid can be tested, these "low concentration" requirements may be followed for all spills of untested mineral oil less than 270 gallons.

Spill Cleanup Requirements:

If reporting requirements apply, notify USEPA office.

If there is visible contamination:

Solid surfaces must be "double washed/rinsed". A volume of solvent in which PCBs are at least 5% soluble sufficient to cover the spill must be used for each of two wash/rinses.

Should the spill reach indoor, residential areas other than electrical vault areas, the surface will be wipe sampled after cleaning and must be less than 10 micrograms per 100 square centimeters. (10 ug/100 cm^2).

All visibly contaminated soil, plus a one foot, not visibly contaminated buffer around the visible spill, must be removed and disposed of. Backfilling must be done to the original contour with less than 1 ppm PCBs clean soil.

If there is no visible contamination:

(An example is where the rain washes away traces of a spill before it can be cleaned up.)

The USEPA regional office should be contacted. The regulations require that a statistically acceptable sampling method be used to define the spill area. USEPA can provide or approve a sampling method to meet this requirement. Their recommended procedures employ 7, 19, or 37 samples, depending on size of the area, to define the spill boundaries.

Timing Requirements:

Cleanup must be completed within 48 hours. Exceptions may be allowed for poor weather conditions, operating or civil emergencies, or lack of access to the site, but not for reasons such as weekend occurrence or need to pay overtime.

Documentation Required:

Cleanup must be certified to be complete by the "responsible party" (the owner).

Documentation and certification must be kept for a period of five years after the cleanup is completed. The records and certification include the following:

- Identification of the source of the release.
- Actual or estimated date of occurrence.
- Date and time cleanup was complete.
- Spill location.
- Spill boundaries and sampling methods.
- Actual procedures followed.

- Certification by the responsible party that policy of 40 CFR 761, Subpart G was followed.
- All test data.

The rule recommends additional documentation. These are not required:

- Post cleanup sampling results, where taken.
- Any documentation of precleanup sampling.
- The cost.
- The time that the cleanup required.

"High Concentration Spills" or "Low Concentration Spills" involving 1 pound or more of total PCBs.

Definition:

Material over 500 ppm PCBs, regardless of amount, or material between 50 ppm and 500 ppm where 1 pound or more total PCBs is spilled or released.

Spill Cleanup Requirements:

Required actions must be initiated within 24 hours. This is extended to 48 hours if release of fluid from a PCB transformer is involved. Exceptions may be allowed for poor weather conditions, operating or civil emergencies, or lack of access to the site, but not for reasons such as weekend occurrence or need to pay overtime.

There are four immediately required actions:

If reporting requirements apply, notify USEPA office.

Cordon off or otherwise delineate an area including the entire spill area and a three foot buffer on all sides.

Document and record visible contamination. If there is no visible contamination, as for example where the rain washes away traces of a spill before it can be cleaned up, the USEPA regional office should be contacted. The regulations require that a statistically acceptable sampling method be used to define the spill area. Regional USEPA can provide or approve a sampling method to meet this requirement.

Initiate cleanup of all visible traces on solid surfaces and initiate removal of visibly contaminated soils.

Timing Requirements:

The USEPA is not requiring a specific time limit for completion of the cleanup. The goals of the policy are for immediate control of the spill area, as indicated by the immediate actions listed above, and for complete decontamination, to the decontamination levels listed below.

Decontamination Levels:

Outdoor Electrical Substations

Solid surfaces must be decontaminated to 100 ug/100 cm^2 as measured by standard wipe tests. This includes both impervious (nonporous) surfaces such as metals and enamels and non-impervious (porous) surfaces such as concrete.

Soil may be cleaned to a level of 25 ppm or to 50 ppm if prominently labeling of the area is done.

An exception to the 25/50 ppm requirement may be granted if it is demonstrated that the integrity of the electrical equipment will be jeopardized.

NOTE:

If the electrical substation is ever decommissioned and converted to other use, it will have to be cleaned in accordance with the requirements for the other use. Outdoor substation requirements are the most lenient in the policy.

Other Restricted Access Areas (Vaults and Indoor Substations)

Cleanliness must be documented by post cleanup sampling according to the type of surface and expected contact by unprotected and/or untrained personnel. High contact areas are surfaces that can be and are touched repeatedly such as doors, walls below 6 feet, stairs, floors, etc. Low contact areas are ceilings, walls above 6 feet, roadways, utility poles, etc. More complete definitions are found in 40 CFR 761.123.

High contact solid surfaces, whether impervious or non-impervious, must be cleaned to 10 ug/100 cm^2.

Low contact, indoor, impervious surfaces must also be cleaned to 10 ug/100 cm2.

Low contact, indoor, non-impervious surfaces must either be cleaned to 10 ug/100 cm^2 or be cleaned to 100 ug/100 cm^2 and encapsulated. The regional administrator is reserved the right to disallow the use of encapsulation and to require the greater degree of cleanliness.

Soil must be cleaned to 25 ppm.

Nonrestricted Access Areas

Furnishings, toys, and other easily replaceable household items must be disposed of in accordance with 40 CFR 761.

All indoor solid surfaces and high contact outdoor solid surfaces shall be cleaned to 10 ug/100cm^2.

Indoor vault areas and low contact, outdoor, impervious solid surfaces shall be decontaminated to 10 ug/100cm^2.

Low contact, outdoor, nonimpervious surfaces must either be cleaned to 10 ug/100 cm^2 or be cleaned to 100 ug/100 cm^2 and encapsulated. The regional administrator is reserved the right to disallow the use of encapsulation and to require the greater degree of cleanliness.

Soil must be cleaned to 10 ppm provided that at least ten inches of soil is excavated and replaced with clean soil, less than 1 ppm, to the original contour.

Documentation Required:

Documentation for the high concentration or large volume spill cleanup is the same as for low concentration spills, with two additions. Cleanup must again be certified to be complete by the "responsible party" (the owner). Documentation and certification must be kept for a period of five years after the cleanup is completed. The records and certification include the following elements described earlier:

- Identification of the source of the release.
- Actual or estimated date of occurrence.
- Date and time cleanup was complete.
- Spill location, in this case including the types of surfaces and materials contaminated by the spill.
- Spill boundaries and sampling methods.
- Actual procedures followed.
- Certification by the responsible party that policy of 40 CFR 761, Subpart G was followed.

Additionally, the sampling protocols required for cleanup require that the cleanup boundary be defined by tests. The documentation for the cleanup must include the sampling program used to identify the boundaries.

Finally, since the high concentration spill policy requires in all cases that post cleanup verification sampling be taken, the post cleanup results must be included in the documentation. Also, if the sampling methodology is not immediately obvious from the sample results, the methods use to define sample locations and methods must be explained.

The regulation also recommends, but does not require that the documentation list the cost in money and time that the cleanup consumed.

Sampling Requirements for High Concentration Spills and Releases

Sampling Area-Whichever is larger: the boundary of the spill, as defined by tests, plus one foot in every direction, OR the area of the original spill plus 20%.

- The sampling scheme must be statistically valid to ensure a 95% confidence level against false positives.

- The minimum number of sample is three, the maximum is forty. The number must be selected so that contamination with a radius of two feet or more will be detected.

- The sampling scheme must include calculation for expected variability and analytical error.

The EPA has a recommended set of sampling protocols: those developed by Midwest Research Institute for use in EPA enforcements inspections-Verification of PCB Spill Cleanup by Sampling and Analysis. Copies of the protocols, and a guide to use-Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup, are available from the TSCA Assistance Office of USEPA. The TSCA Information Hotline phone number is (202)554-1404.

Bottom Line of the Spill Cleanup Policy

One important aspect of the spill cleanup policy is that compliance on the part of the owner/responsible party creates a presumption against further enforcement actions and further cleanup requirements.

This means that a good faith effort to clean an accidental spill, that results in the mandated levels of cleanliness, will not be subject to a fine or to requirements for further action. The EPA reserves, however, authority under the policy, to monitor compliance with mandated cleanup levels and to levy enforcement actions in the cases of willful or grossly negligent conduct leading to a spill or release.

Review of the High Points

The first thing that needs to be done in the event of the spill is to contain the spill, to stop the leak and amount of material released, and to determine the concentration and quantity of material spilled. Also, the surfaces and areas contaminated need to be characterized.

Once these two tasks are performed, the owner is responsible under the policy for complete compliance with all of the requirements for reporting the spill, sampling methods and spill boundary definition, timing and methods of cleanup, and the final cleanliness levels. If all of these tasks are documented to have been performed, in consultation with the EPA where necessary, the owner/responsible party can greatly reduce the future liability for regulatory compliance resulting from a spill.

PART II

Disposal as an Alternate Response

The inspection and reporting requirements of complying with the PCB regulations represent a significant cost. Also, since quarterly inspections allow a lot of time for leaks to develop and worsen, performing the mandated inspections is not guarantee that leaks and spills requiring cleanup will not happen. Rather than hope that the operation can continue without a leak or spill of PCBs, there are really only three other choices for managers and building owners:

- Step up inspection and maintenance frequencies and budgets to some "comfort level" where the owner may be confident that leaks will be caught and corrected before cleanup becomes a major expense.

- Budget an annual contingency for cleanups so that funds are available to address cleanup requirements.

- Remove the PCB risk by removing and disposing of the equipment.

Any of the three can be a viable response when funded and performed properly. In most cases, industrial facilities are choosing to remove and dispose of the equipment. Done properly, disposal can be the most cost effective and permanent solution regarding the issue of PCB risk management.

However, when done imprudently, disposal can be a source of continuing or increased liability. The second part of this paper discusses the avenues owners have for the disposal of PCB and PCB contaminated equipment, and which of those avenues pose difficulties that may prevent them from being permanent, cost effective solutions.

Definitions and Regulations Related to Disposal

NonPCB, PCB Contaminated, and PCB fluids and electrical equipment are defined in 40 CFR 761, and allowed methods of disposal for both fluids and solids are described. In summary,

- NonPCB Fluids contain less than 50 ppm PCBs.
- NonPCB equipment contains or previously contained nonPCB fluid less than 50 ppm PCBs.
- PCB Contaminated equipment contains or previously contained fluid contaminated by 50 to 499 ppm PCBs.
- PCB equipment contains or previously contained fluid 500 ppm or greater ppm PCBs.

NOTE: While it is in a transformer, fluid 50-499 ppm PCBs is "contaminated". Outside a transformer, free fluid is either non-PCB (less than 50 ppm) or PCB (50 ppm and over).

NonPCB equipment and fluids are not generally regulated under 40 CFR 761 for disposal. PCB Contaminated empty transformer carcasses are not regulated, but the fluids, including any residuals left in drained units, are regulated. PCB equipment and fluids are regulated.

Regulation of fluids and solids depends on current, acceptable test data on recent samples or on the knowledge the unit contained PCB fluid or that the source of a spill was a regulated fluid.

Nonliquid materials, including soils, debris, concrete, rags, etc., containing 50 ppm or greater PCBs are regulated for disposal.

Dredged materials and sludges containing 50 ppm or greater PCBs are regulated for disposal.

Hydraulic systems contaminated by PCBs are not regulated for disposal, if drained, except that 1.) fluids contained in such systems that are 50 ppm or greater PCBs are regulated, and 2.) if the fluid PCB content was 1000 ppm or greater, the system must be flushed with an acceptable solvent before disposal.

Large PCB capacitors are regulated for disposal. Small capacitors, nonPCB capacitors, and fluorescent light ballasts are not regulated by 40 CFR 761.

A PCB small capacitor is a PCB capacitor meeting one of the following three criteria:

- If the amount of fluid is known, a small capacitor contains less than three pounds of dielectric fluid.
- If the amount of fluid is not known, a capacitor is classified as small if it is less than 100 cubic inches in volume.
- If the amount of fluid is not known and the volume is larger than 100 cubic inches, but less than 200 cubic inches, the capacitor is still considered to be small if the total weight is less than nine pounds.

If any of the following conditions apply, a capacitor containing PCBs is considered to be a large capacitor:

- The capacitor contains more than three pounds of fluid.
- The capacitor is larger than 200 cubic inches in volume.
- The capacitor is larger than 100 cubic inches in volume, but smaller than 200 cubic inches, and weighs in total more than nine pounds.

A PCB "light ballast" that exceeds this size limits is regulated as a large capacitor.

Approved methods of disposal for regulated materials include:

Fluids less than 500 ppm

- Incineration.
- Burning in an approved high efficiency boiler.
- Dechlorination by an EPA approved alternate disposal method.

Fluids greater than 500 ppm.

- Incineration.
- Dechlorination by an EPA approved alternate disposal method. The practical limit on dechlorination, based on economics and permit restrictions is about 5,000 ppm PCBs.

Electrical equipment carcasses greater than 500 ppm.

- Burial in an approved chemical waste landfill. This requires "decommissioning": a special drain and flush procedures. Some of the flush solvents specified under the TSCA PCB regulations, including toluene and xylene, are banned from land disposal under the RCRA land ban regulations.
- Approved alternate disposal method for destruction of PCBs and recycling of carcass components.

NOTE: Drained PCB Contaminated electrical equipment is not regulated for disposal.

Contaminated solids greater than 50 ppm

- Incineration.
- Burial in an approved chemical waste landfill.

Regulated capacitors

- Incineration.

Further:

Owners of mineral oil transformers can assume that the units are PCB Contaminated for purposes of keeping them in service.

The owner in all cases is ultimately responsible for proper disposal. The owner, as generator, is also responsible for the PCBs so long as they continue to exist. Legally allowed disposal does not insulate the owner from this liability.

Problems Caused by "Legal" Disposal Methods

There are two areas, in particular, where owners do not eliminate, and usually actually increase, their risks of incurring PCB liability by utilizing disposal methods that are allowed under the regulations.

- Land Disposal of PCB Equipment Carcasses
- Disposal by Scrapping of nonPCB and PCB Contaminated Equipment Carcasses

Land Disposal of PCB Equipment Carcasses

Liability for materials placed in a landfill is perpetual. These materials are still the ultimate responsibility of the generator who sent them there, regardless of any contractual arrangements to reduce that liability or place it on third parties. In some cases, land disposal is the only viable alternative. Where alternatives exist, however, owners are better off pursuing those alternatives.

The risk of incurring liability through landfill of PCB equipment carcasses is high, and the definition of the severity of that liability is improving all the time. As an added risk, manifesting of transformer carcasses indicate clearly the generators responsible for carcasses contained in the landfill. Tracking of units by serial number will make it easy to identify potentially responsible parties when the cleanup bills come due.

Fortunately, EPA has approved alternate methods of disposal for PCB transformer carcasses to address the problems associated with landfills.

The best available technology commercialized over the past few years affords owners the opportunity to destroy the equipment, ending the chain of liability for the PCBs, while recycling the important resources contained in the transformer into the economy. This offers the owner two important benefits:

- By using total destruction, the owner can define an end to the PCB equipment, as well as the owner's liability for it. This alternate disposal method is approved and allowed under 40 CFR 761. In order to be destroyed in the approved process, the transformer must be tested and documented to have been cleaned of residual PCBs to less than 10 micrograms per 100 square centimeters, a level defined in the approval as now being "nonPCB". Once the Certificate of Destruction is issued, the transformer no longer exists and cannot become a source of future liability.
- Because the process recycles important resources, transformer destruction is an environmentally responsible use of best available technology to minimize generation of waste. 85-90% of the drained transformer carcass is recyclable metal. This does, in fact, qualify under most industrial and government waste reduction programs.

Disposal of nonPCB and PCB Contaminated Transformers

Disposal of nonPCB and PCB contaminated transformers through recycling can pose problems of increased risk for transformer owners if care is not taken in securing a vendor for these services. Legitimate, EPA approved vendors of transformer recycling services compete with scrappers who use little or no controls to prevent the release and spread of PCB contamination. Although there are no federal regulatory requirements for carcasses contaminated with less than 500 ppm fluid, disposal of these carcasses through scrapyards may present unacceptable risks from several standpoints.

a. Disposal of carcasses via procedures with poor quality control or with less than scrupulous handling procedures results in contamination of disposal sites by 50-500 ppm oil. There are two problems that arise.

   First, such contamination amounts to an illegal disposal of regulated material, since disposal of all oil over 50 ppm is regulated. Second, such improper handling results in a gradual contamination of the site with measurable levels of PCBs. Sites that have never been documented to have handled regulated carcasses have become progressively and severely contaminated.

b. Scrapyards frequently dispose of waste generated in the scrapping of transformers along with other debris in municipal or sanitary landfills. While federal regulations may allow landfill disposal in unregulated sites, most municipalities and a number of state agencies reject items with measurable PCB content, regardless of level of contamination. Worse, oil soaked paper, etc., contaminated with measurable PCBs, may be stored in piles in the scrapyard where rain can wash the contamination into the soil.

c. Documentation of proper disposal, while it may not be required by regulation, is the only risk management tool available to substantiate that appropriate care was taken during the disposal of unregulated transformers.

d. Scrapyards simply do not have the quality control structures and procedures to protect the owners interests. Scrapping is most frequently done outdoors, with no containment to prevent migration of PCB contamination.

Using a scrapper to dispose of nonPCB and PCB Contaminated units, while "legal", exposes the owner of the transformers to increased liability with regard to future cleanup of the site and to noncompliance with USEPA regulations.

1. The owner may be held liable if the scrapper contaminates the environment through improper activities, such as scrapping over 500 ppm units or spilling or leaking over 50 ppm oil.

2. Even if no improper activities occur, experience shows that these uncontrolled sites have become contaminated by PCBs. In the absence of a funded closure plan, experience shows that the government will clean up the sites and then approach the owners who sent transformers for scrapping for reimbursement of cleanup costs.

A Three Part Solution

The solution to these difficulties with landfills and with scrappers contains three equally important parts.

1. Specification of disposal methods that completely destroy PCBs, ending the lingering liability posed by land disposal of PCBs.

2. Utilization of transformer destruction vendors that can disassemble, clean up, and destroy transformers regardless of PCB levels and that are EPA approved and inspected.

3. Selection of vendors who go beyond EPA requirements by instituting more stringent monitoring requirements for contamination. This provides assurance that the spread of contamination is eliminated and to provide sufficient security for customers.

   All operations involving PCBs and contaminated oils should be performed indoors, within contained areas, and on sealed, protected surfaces.

An Approved Alternative

S. D. Myers, Inc. (SDMI) offers two processes, Material Recovery® and Resource Recovery®, to destroy and recycle transformers regardless of PCB content, from none detected to pure askarel (100% PCB).

As opposed to landfill disposal which carries a never ending, nonassignable risk of future liability, disposal of transformers by complete destruction and recycling of components provides a defined and recognizable end to the chain of liability. When the transformer is destroyed and the destruction is documented, the transformer can no longer be a source of future liability.

All components, aside from being cleaned to safe levels in accordance with our permits, are reduced so that they lose there identity as a part of any customer owned equipment.

All PCBs are destroyed in EPA approved facilities, by EPA approved methods. All materials that can be cleaned and recycled are cleaned, documented to be clean, and are processed for recycling by smelting.

Processes

Resource Recovery®

Resource Recovery® is the name of our service for completely decommissioning, cleaning, destroying, and recycling PCB transformers, those where the transformer fluid is 450 ppm PCBs or greater.

Resource Recovery® was developed to fulfill three major market objectives:

1. To provide for the decommissioning, decontamination, destruction, documentation, and recycling of "askarel" or "pure PCB" transformers in an appropriately permitted and approved process.

2. To provide the same service for mineral oil units 450 ppm PCBs and greater.

3. To provide the same service for equipment that is not regulated. The Resource Recovery® process provides owners of nonregulated equipment with a powerful risk management tool: the application of S. D. Myers cleaning, testing, and documentation protocols, as permitted by the EPA and as reviewed by our environmental staff, outside environmental consultants, and several regulatory agencies, to low level PCB contaminated wastes.

Resource Recovery® consists basically of the following elements:

1. Transformers are disassembled under controlled conditions and all components that can be incinerated such as fluids, paper, and wood are sent to a permitted incineration facility.

2. Metals and ceramics are subjected to a proprietary cleaning process to reduce PCB surface contamination to safe levels less than 10 micrograms per 100 square centimeters.

3. The materials used in the cleaning process are recovered in a proprietary recycling process. All concentrated PCBs recovered during the process are incinerated.

4. The clean components of the transformer are further processed by smelting to facilitate recycling of the materials and to provide a documented end to the equipment's life and integrity.

The net result of the process is that the PCB equipment is completely destroyed, all contained PCBs are destroyed, and all recyclable components are reclaimed.

Material Recovery®

The Material Recovery® process is used to decontaminate, destroy, and recycle PCB contaminated and non PCB transformers with fluid contamination levels less than 450 ppm PCBs. We use this level, rather than the regulatory cutoff of

500 ppm, to accommodate the EPA's desired safety margin for gas chromatography accuracy and precision.

While the process differs considerably from Resource Recovery®, the net results are effectively the same. Transformer components are separated, PCBs are destroyed under controlled conditions, and recyclable metals and ceramics are recycled.

While the carcasses are not regulated under PCB rules, all fluids over 50 ppm, including any residual left in drained units, are regulated, and the Material Recovery® process takes great care to document that the handling and decontamination of these fluids are performed in accordance with all aspects of our permits and applicable regulations.

Conclusion

For prudent management of PCB risks:

1. Care needs to be taken and procedures followed to guard against the spill or release of PCB fluids.

2. Should PCBs be spilled or released in spite of precautions, cleanup needs to be performed in accordance with regulatory requirements and especially needs to be documented.

3. Where removal and replacement of PCB equipment is chosen as a management option for controlling PCB risks, disposal of the equipment needs to be performed to utilize the best available technology for minimizing risks of future liability.

4. Recycling, not land disposal, is the permanent solution to disposal requirements.

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SIMPLIFIED SELECTION OF OVERCURRENT PROTECTIVE DEVICES

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INTRODUCTION

Low voltage power distribution systems have changed over the years. Today electrical distribution systems now have higher fault currents than ever before. Several areas in North America have available short circuit currents in excess of 200,000 amperes. As the power requirements grow, the available fault currents tend to increase, and the protection of electrical components becomes more critical. The selection of the proper overcurrent protective devices needs to be closely studied. This paper examines new technology available that simplifies the selection of electrical overcurrent protective devices through the use of 300,000 amp interrupting rated fuses.

AMPS INTERRUPTING RATING (AIR)

The 1990 National Electrical Code defines "Interrupting Rating" as "The highest current at rated voltage that a device is intended to interrupt under standard test conditions." Section 110-9 states:

"Equipment intended to break current at fault levels shall have an interrupting rating sufficient for the system voltage and the current which is available at the line terminals of the equipment.

Equipment intended to break current at other than fault levels shall have an interrupting rating at system voltage sufficient for the current that must be interrupted."

In essence, this section of the NEC emphasizes the difference between clearing fault level currents and clearing low level over currents. Protective devices such as fuses and circuit breakers are designed to clear fault currents and therefore must have short circuit interrupting ratings (AIR) sufficient to withstand such fault levels.

As shown in Figure 1, the available fault current must be determined. After calculating available short circuit current at the line terminals of the equipment, the overcurrent devices can then be evaluated to determine if the interrupting ratings are adequate.

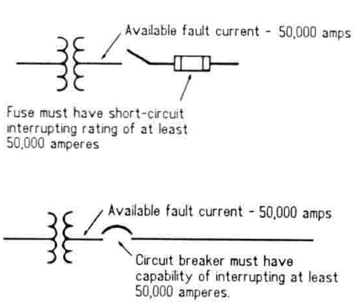


Figure 1

INTERRUPTING CAPACITY VS INTERRUPTING RATING

An important distinction should be made between the terms interrupting capacity and interrupting rating.

Interrupting rating refers to the highest current at rated voltage that a device is intended to interrupt under standard test conditions. Interrupting capacity refers to the highest current at rated voltage that the device actually interrupts under test conditions. The distinction made between the terms lies in the manner in which overcurrent protective devices, both circuit breakers and fuses, are tested.

Circuit breakers are given a short circuit interrupting rating per UL test standard 489. This standard calls for a calibrated test circuit waveform to be set up at a specified short circuit current available, at a given power factor, at a specific system voltage. Once the test waveform is calibrated, rather than apply the circuit breaker directly to the test bus, a circuit breaker is allowed to be tested with 4 feet (per pole) of rated wire applied to the line side and 10 inches (per pole) of rated wire applied to the load side of the breaker. Thus, the test current the circuit breaker actually is tested to can be significantly reduced by the impedance of the wire inserted into the test circuit. The power factor also is affected by the change that occurs with the added impedance. The effect of this addition of 4'10" of wire per pole can be dramatic. An example of this effect can be seen with a 240V, 20 Amp, 2 pole molded case circuit breaker with an interrupting rating of 22,000 amps.

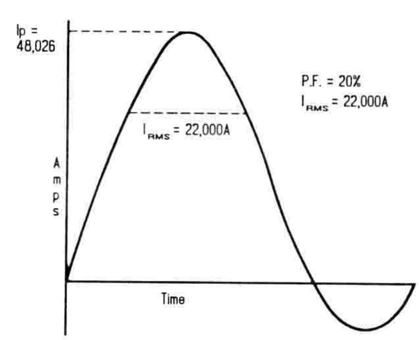
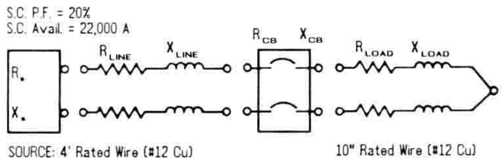


Figure 2

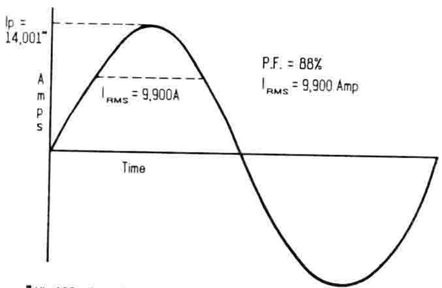
Figure 2 shows the calibrated waveform that is set up, in this case for an RMS symmetrical current of 22,000 amps. Figure 3 then shows the impedance that is placed between the source and the test device. This device is labeled with an interrupting rating of 22,000 amps has been tested to a value of 9900 amps RMS, because of the impedance of the rated wire that is inserted into the circuit. Figure 4 shows the waveform the breaker is actually tested to interrupt. Therefore, the actual test conditions dictate that the interrupting capacity is only 9900 amps. It is recommended that this interrupting capacity be compared to the available fault current. The breaker is not typically tested above this value, but carries an interrupting rating that may lend itself to misapplications. The effect of applying circuit breakers beyond their interrupting capacity is not strictly a violation of section 110-9 of the code, but may result in a serious safety problem that the average engineer may not be aware of. The interrupting capacity of a branch circuit fuse is equal to or greater than its interrupting rating.

CH3111-2/92/0000-0009 $1.00 © 1992 IEEE



Note: For calculations, R_{CB} and X_{CB} are assumed negligible.

Figure 3



*UL 489 allows for a random close during the short circuit test, so the peak available current may be as low as 1.414 times the RMS symmetrical current.

Figure 4

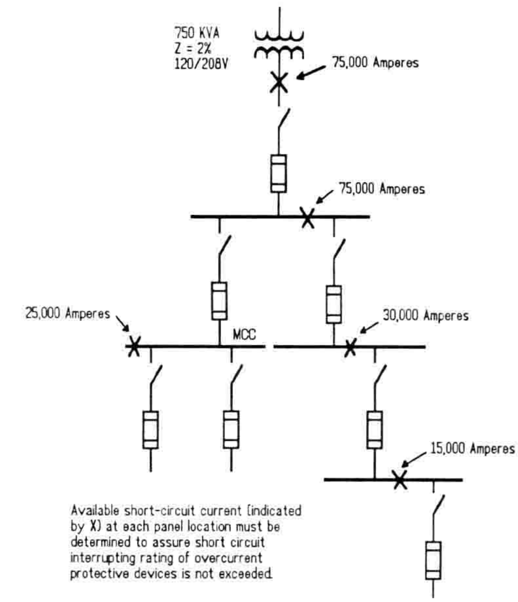


Figure 5

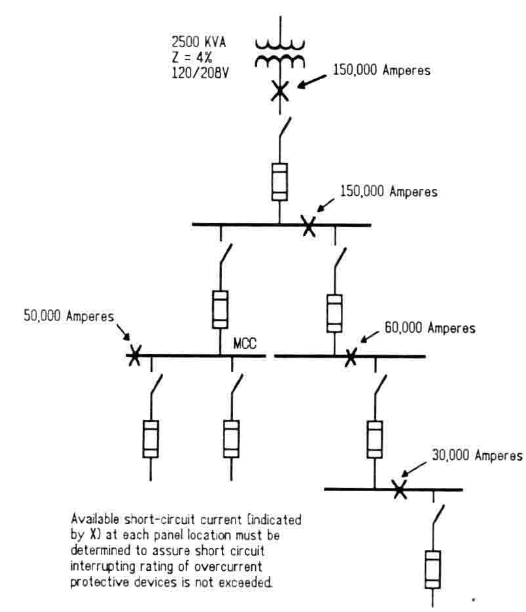


Figure 6

INCREASING FAULT CURRENTS

The problem that has occurred in many industrial plants in this country is that there exists violations of Section 110-9 of the National Electric Code. These violations have often occurred, not through the fault of the plant engineer or maintenance personnel, but through the fact that fault currents have increased over the years. The available fault current that exists in an electrical system is determined by several factors, including the power source that is feeding the system, and the service transformer. Relative to the transformer, the fault current available can be affected by two factors, the first of these being the size of the transformer, and the second being the impedance of the transformer. A rule of thumb is that if the KVA of the transformer doubles, the available fault current doubles. If the impedance of a transformer is cut in half, representing a more efficient transformer, the available fault current can double. Todays' modern power transformers are more efficient than ever before. To illustrate, oil filled transformers built in the 1960's typically carried a % impedance that ranged from 5.75% to 9.00%. Today, the % impedance of oil filled transformers typically ranges from 2.00% to 5.50%. What has happened in modern systems is that older transformers that feed industrial plants are replaced over time with either larger transformers that are more efficient (lower impedance) or the same size transformer that is more efficient. As mentioned, each of these conditions has a dramatic effect on the available short circuit current.

Figures 5 and 6 show the effect of a change to the transformer feeding a distribution system. In this case, a larger transformer was put into service and the available short circuit current essentially doubled throughout the system. The problem that exist in industry today is that the overcurrent protective devices that had adequate interrupting ratings before the change over, may now be inadequate. When a change to the power system occurs, and the overcurrent protective devices are not checked, not only can there be a violation of Section 110-9, but more importantly the safety factor in the plant has been compromised. This fact alone emphasizes the need for an engineer to design a system that won't be outdated as a plant grows, or when changes are made to the electrical system.

REDUCING AN ENGINEERS'S LIABILITY

Many newer installations today have over 200,000 amps of available fault current. There are additional locations where over 150,000 amps of fault current exist, and that's without the addition of motor contribution, since a motor will act as a generator and contribute to the fault current under the condition of a short circuit. Therefore, these locations have the potential for over 200,000 amps of available short circuit current. For these reasons, a need has arisen for overcurrent protective devices to have an interrupting rating of greater than 200,000 amps. Certain standard UL listed Class L time delay fuses (601 amps to 6000 amps), Class RK1 time delay fuses and Class J time delay fuses have recently been given additional "Special Purpose" listings at 300,000 amperes. An engineer designing with this type of system can limit his or her liability as a result of changes to a power system in subsequent years. The end user is given a system that will not soon be outdated as changes occur and also allows an additional safety factor. Fuses of a higher interrupting rating can also allow the plant engineer or electrical maintenance manager to analyze traditional existing systems and upgrade the safety factor by replacing older style fuses with upgraded protection. Fuses that are current limiting and carry a 300,000 amp interrupting rating can replace Class H fuses, Class RK5 and other Class RK1 fuses. As many as 47 other types of fuses can be replaced by one fuse carrying this higher rating. The end result can be a safer work area with less chance of misapplication.

COMPONENT PROTECTION

An engineer designing a new system or maintaining an existing electrical system should be concerned with protecting all components in the system. The components addressed are those such as wire, motor starters, transfer switches and busway. All components have a certain withstand rating that cannot be exceeded by the available short circuit current. The overcurrent protective devices selected must be able to limit the energy let-through of fault currents to levels below the tested withstand ratings of the system components. Section 110-10 of the National Electric Code deals with component protection. This section of the code states:

"Circuit Impedance and Other Characteristics. The overcurrent protective devices, the total impedance, the component short-circuit withstand ratings, and other characteristics of the circuit to be protected shall be so selected and coordinated as to permit the circuit protective devices used to clear a fault without the occurrence of extensive damage to the electrical components of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors, or between any circuit conductor and the enclosed metal raceway."

The easiest and most effective way to provide protection to all components is through the use of modern current limiting devices. Many of the components used in today's systems require current limiting devices that are extremely fast acting. By definition, a current limiting device must sense a fault condition and safely interrupt in less than 1/2 cycle. Some amount of energy will be let-through. How much is let through determines an overcurrent protective devices' current limiting ability.

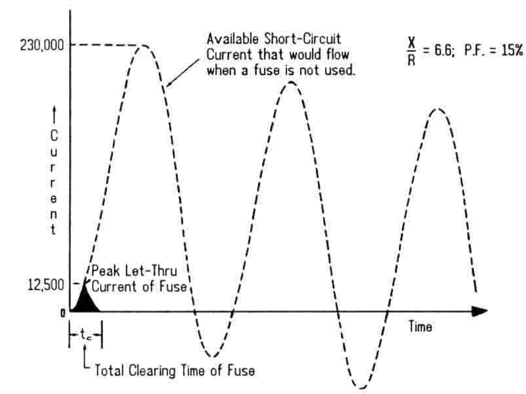


Figure 7

Figure 7 shows the current limitation of a current limiting fuse. In this example, if the fuse were not in the circuit, the available short circuit current of 230,000 amps of peak current would be allowed to flow. Since the fuse is current limiting, it can clear the fault in less than 1/2 cycle and allows only 12,500 amps of peak current to be let thru to the other components that it is protecting.

An example of a high degree of protection required can be illustrated in the protection of motor starters. Specifically, there has been an advent of smaller, application sensitive devices under the IEC (International Electrotechnical Commission) standard now being used. Traditionally, NEMA (National Electrical Manufacturer's Association) starters have been the prevalent choice in this country. Now, as panel space becomes a premium, much consideration and use has been given to IEC starters. IEC starters typically carry a much lower withstand rating than the equivalent size NEMA starter. With this type of starter, greater current limiting protection is required under short circuit conditions. Protection of these devices falls under two categories - Type 1 and Type 2. Essentially, this breaks down as Type 1 protection allowing considerable damage to the device and Type 2 protection allowing no damage. Current limiting fuses such as time delay Class RK1, and time delay Class J, time delay fuses are available to provide Type 2 protection. Installing a current limiting overcurrent device with a 300,000 amp interrupting rating not only can prevent interrupting rating problems with high available fault currents, but can also protect components against excess let-through energy.

SUMMARY

In summary, there exists a need today for a higher amp interrupting rated overcurrent protective device. Higher power demands and more efficient transformers produced today make available short circuit currents greater than ever before. Many locations exist where there are over 200,000 amps available. Section 110-9 of the National Electric Code addresses the fact that an overcurrent device has to be able to safely interrupt the fault current available. If the fault current increases and the overcurrent devices' rating is no longer adequate, a hazard exists. Overcurrent protective devices now rated for 300,000 amps provide protection today and limit decreases in safety in the future.

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