Polychlorinated Biphenyl Compliance Issues in the 21st Century: Poorly Recognized and Potentially Devastating-8162

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ABSTRACT

Thirty-one years have passed since the United States Congress passed the Toxic Substances Control Act (TSCA) [1]. The 1976 law essentially eliminated future production of polychlorinated biphenyls (PCBs) within the United States and greatly limited the use of previously manufactured PCBs and PCB products. The ultimate objective of the law was the complete elimination of these chemicals due to concerns about their potentially toxic effects on health and the environment.

PCBs were manufactured in the United States between 1929 and 1977. They were highly valued for their fire and heat-resistance properties and for their chemical stability. As a result, PCBs were used in a variety of thermally and/or chemically stressful applications. They did not conduct electricity and therefore were particularly well-suited for use as insulating fluids in high-voltage electric equipment. PCBs were also used in various other applications, such as in hydraulic and heat transfer fluids.

Strict controls on the use and disposal of PCBs were imposed by the TSCA implementing regulations at 40 CFR 761 [2]. As a result, most heavy users of PCB products worked hard to curtail their PCB use. Many organizations that once used substantial amounts of PCBs, subsequently declared themselves “PCB free”.

Unfortunately, in many cases, these “PCB-free” declarations were premature, as PCBs were used in many more applications than insulating fluids. From the 1990s and to the present day, PCBs increasingly have been discovered in non-liquid forms. These materials were used or installed in facilities constructed before the 1979 “PCB ban”. Examples include applied paints and coatings, caulking, pre-formed joint filler, and plastic or rubber wire and cable insulation. Proper identification of these materials is necessary for appropriate and compliant waste management during deactivation and decommissioning (D&D) activities.

PCBs can pose other significant waste management issues for D&D projects, particularly for nuclear facilities. Depending upon the waste form and the intended disposal path, PCBs can be regulated at thresholds in the low parts-per-billion (ppb). These low regulatory thresholds often are overlooked due to the erroneous belief by many waste management professionals that materials containing PCBs are regulated by TSCA only if their PCB concentration is at least 50 parts-per-million (ppm). Failure to recognize when and how the lower thresholds apply can lead to rejection of the waste materials by treatment, storage and disposal (TSD) facilities as well as potential regulatory non-compliance. Furthermore, re-use of “excess” materials with PCBs is also regulated by TSCA. In the event of a characterization error, the costs required to make necessary corrections can be very high.

This paper will focus on PCB characterization and waste management issues associated with D&D of DOE nuclear facilities. It will identify PCB materials that are likely to be present in such facilities, with emphasis on the non-liquid PCB forms. The paper will discuss characterization pitfalls associated with Non-Liquid PCBs (NLPCBs), including circumstances in which NLPCBs can migrate into other materials. The paper also will identify TSCA requirements for materials with very low concentrations of PCBs; certain materials are regulated at concentrations as low as 0.5 µg/L PCBs (approximately 0.5 ppb). The paper will then examine the potentially extensive impacts to a facility if the materials are not managed in a TSCA-compliant manner. Examples from a recent D&D project at the DOE Savannah River Site will be used to illustrate key points and lessons learned. It is expected that this information would be useful to other DOE sites, DoD installations and commercial nuclear facilities constructed prior to 1979.

INTRODUCTION

The major objective of the Toxic Substances Control Act of 1976 (TSCA) was the control and ultimate elimination of polychlorinated biphenyls (PCBs). The primary use of PCBs was as insulating fluids, mostly in electrical equipment. Approximately 850,000,000 pounds of PCBs, representing approximately 60% of total PCB production, were used in such applications. An additional 10% of PCBs produced were used as hydraulic fluids and lubricants [3]. Utilities and government facilities expended enormous effort and expense to eliminate or reduce their use of PCB fluids. By the end of the 20^{th} century, many organizations believed they had solved their PCB problems.

However, an entirely different set of PCB issues now exists for many facilities constructed prior to the 1979 TSCA ban on production of PCBs. Difficult compliance issues involve uses of non-liquid PCBs (NLPCBs) that were barely recognized when TSCA was passed. Some of the commercial PCB mixtures, called Aroclors, were effective plasticizers in many materials. Approximately 350,000,000 pounds, or 25% of all PCBs produced, were used as plasticizers. An additional 71,000,000 pounds (5% of production) were used in miscellaneous applications such as flame retardants, sealants, carbonless copy paper, and paints (does not include PCBs used in certain paints as a plasticizer) [3]. NLPCBs typically can be found in products such as paints and coatings, caulking and joint filler, rubber and felt gaskets, plastic and rubber cable insulation, and certain roofing materials. These materials were used in many radioactive processing facilities as they were exceptionally durable.

Substantial volumes of NLPCBs are present both in legacy wastes and in wastes currently being generated. NLPCBs can be the key determinant in selection of compliant waste processing, storage, treatment and disposal options. Failure to identify the presence of NLPCBs in a facility can result in significant characterization errors that may lead to potential regulatory violations. NLPCBs are usually stable, but under certain conditions they can migrate into other materials; this increases the potential for waste characterization errors. Unfortunately, there is limited knowledge about NLPCBs within the overall waste management community.

Regardless of the PCB source, certain provisions of TSCA are difficult to meet. For example, TSCA thresholds for use, decontamination, and disposal of water, are in the low part-per-billion (ppb) range. Treatment options can be very limited, particularly for radioactive materials. When certain organic compounds are also present in a material, it can be difficult for a laboratory to detect PCBs at concentrations low enough to determine if treatment under TSCA is required or whether applicable treatment or use standards have been attained.

Facilities undergoing D&D are particularly likely to encounter these difficult-to-manage PCBs. D&D activities may generate excess or waste materials that are TSCA-regulated despite low PCB concentrations. Such materials may be regulated both for re-use and for disposal. D&D activities may also generate large volumes of NLPCB wastes that may be difficult to manage. The DOE Savannah River Site (SRS) has encountered many of these materials and the associated challenges in the course of its ongoing D&D program.

SRS has conducted an aggressive D&D program for the last several years. Dozens of process and support facilities have been removed from this 310 square mile complex. Many of these facilities were constructed in the 1950s and 1960s, which was a time of active PCB manufacturing and use. Identification of PCB materials, including NLPCBs, is integrated into the facility characterization and waste management process. However, PCB materials have occasionally posed difficult and unexpected project management challenges and provided significant “lessons learned”, both for future D&D initiatives and for active SRS facilities.

IDENTIFICATION AND CHARACTERIZATION OF PCBs IN THE 21^{st} CENTURY

This paper focuses on identification and management of PCBs in forms and uses that are not widely recognized, particularly the various non-liquid forms. However, even with equipment commonly recognized as potentially containing PCBs, certain characterization pitfalls are possible. The most serious ones involve transformers that once contained regulated levels of PCBs but subsequently were treated/retrofilled to reduce their PCB level to “Non-PCB” status, i.e., < 50 ppm. Since D&D activities can range from removal of a single pad transformer to an entire substation, it is worthwhile for D&D personnel to be aware of these pitfalls. Key information and potential characterization pitfalls associated with oil-filled equipment and other TSCA-authorized PCB uses will be discussed first, followed by the non-liquid PCB forms and their unique issues.

PCB-Containing Equipment and Materials Authorized by TSCA Regulations

The process of identifying potential sources of PCBs in a given facility historically has emphasized oil-filled equipment. This is a necessary element of facility and waste characterization. Table I summarizes the PCB equipment and materials that currently are specifically authorized for continued use by TSCA regulations. Most are oil-filled items that are widely recognized as potentially containing PCBs. Generally, D&D projects include staff members who are well aware of the types of oil-filled equipment in which PCBs commonly were used. However, a few materials/items listed in Table I (marked with an asterisk) were added in the 1998 PCB Disposal Amendments [4] and are not as commonly known. All of these materials and items should be evaluated as part of the D&D facility/waste characterization process, including the potential characterization pitfalls identified in this paper.

Table I. PCB-Containing Equipment and Materials Authorized by TSCA Regulations [2]

Equipment or Material	Characterization Basis
Transformers	Disposal Requirements are based on PCB concentration. Regulated for disposal if liquid has ≥ 50 ppm PCBs; requirements are stricter if there are ≥ 500 ppm PCBs.
Railroad Transformers	Disposal requirements based on PCB concentration. Current equipment authorized for ≤ 1,000 ppm PCBs.
Mining Equipment	Disposal requirements based on PCB concentration. Current equipment only authorized for < 50 ppm PCBs.
Heat Transfer Systems	Disposal requirements based on PCB concentration. Current equipment only authorized for < 50 ppm PCBs.
Hydraulic Systems	Disposal requirements based on PCB concentration. Current equipment only authorized for < 50 ppm PCBs.
Carbonless Copy Paper	Disposal requirements based on PCB concentration. Manufacturing ended with the PCB ban in 1979.
Electromagnets	Disposal Requirements are based on PCB concentration. Regulated for disposal if liquid has ≥ 50 ppm PCBs; requirements are stricter if there are ≥ 500 ppm PCBs.
Switches (including sectionalizers and motor starters)	Disposal Requirements are based on PCB concentration. Regulated for disposal if liquid has ≥ 50 ppm PCBs; requirements are stricter if there are ≥ 500 ppm PCBs.
Voltage Regulators	Disposal Requirements are based on PCB concentration. Regulated for disposal if liquid has ≥ 50 ppm PCBs; requirements are stricter if there are ≥ 500 ppm PCBs.
Natural Gas Pipeline Systems*	Requirements are complex. Consult TSCA regulations.
Scientific Instruments	Disposal is based on PCB concentration.
Capacitors (including small capacitors in fluorescent light ballasts)	Disposal requirements are based on capacitor size and PCB concentration. Ballasts may also contain PCBs in the non-liquid "potting material" and be regulated as PCB Bulk Product Waste* per 40 CFR 762.62 (added by the 1998 PCB Disposal Amendments.
Circuit Breakers, Reclosers & Cable	Authorization for cable pertains to the oil in oil-filled cable. PCBs also may be present in the plastic or rubber insulation.
Porous surfaces contaminated with liquid PCBs*	Regulated for disposal as PCB Remediation Waste per 40 CFR 762.61 (added by the 1998 PCB Disposal Amendments.)*
Air Compressor Systems*	Requirements are complex. Consult TSCA regulations.
Other Gas or Liquid Transmission Systems*	Requirements are complex. Consult TSCA regulations.

* Authorized in the 1998 PCB Disposal Amendments [4]

Note: Table I includes references to certain PCB concentrations that are regulatory thresholds for the particular items. Those concentrations are expressed in terms of bulk concentrations, e.g., 50 ppm in a liquid or solid material.

When it is not possible to obtain a bulk sample of a PCB source material, characterization is performed by collecting and analyzing a “wipe sample” of the item or material’s surface. Wipe samples must be collected per the EPA’s “standard wipe test” protocol [5], which is available on the EPA-Headquarters PCB web site at www.epa.gov/epaoswer/hazwaste/pcbs/. The sample is collected by rubbing a solvent-soaked gauze or glass wool in a prescribed manner over a 100 cm^2 surface area. After analysis, the surface or item is assigned a PCB classification as shown in Table II.

Table II. Categorizing Materials Based on PCB Surface Contamination Levels [2]

“Non-PCB”	“PCB-Contaminated”	“PCB”
A surface contamination level of : ≤ 10 μg PCBs/100 cm^2 is regulated in the same manner as: PCBs that are < 50 ppm in solids or free-flowing liquid	A surface contamination level of: > 10 μg PCBs /100 cm^2 but < 100 μg PCBs /100 cm^2 is regulated in the same manner as: PCBs that are ≥ 50 ppm but < 500 ppm in solids or free-flowing liquid	A surface contamination level of: ≥ 100 μg PCBs/100 cm^2 is regulated in the same manner as: PCBs that are ≥ 500 ppm in solids or free-flowing liquid

Characterization Pitfalls Related to Oil-Filled Equipment

The following situations/equipment can lead to characterization errors, which in turn could lead to improper disposal and regulatory non-compliance. D&D personnel can encounter any or all of these four situations during a project.

The first pitfall is associated with “leach-back” of PCBs from the internal components of transformers and other oil-filled equipment that formerly contained regulated levels of PCBs. Thousands of pre-TSCA PCB-containing transformers were “retrofilled” to reduce their PCB concentration. This process involved draining, flushing and refilling the equipment with PCB-free oil in accordance with TSCA regulations. The equipment could exit TSCA regulation completely if the PCB concentration was < 50 ppm after completion of the specified procedures. However, the PCB concentration in the fresh oil can creep back to regulated levels over time. This is because the internal components of the typical transformer include many chambers and a substantial amount of porous materials. The original, higher concentration PCBs would migrate deep into those materials and then subsequently release into the fresh oil. Caution is necessary when removing these retrofilled transformers from service. Updated testing is advisable to ensure that the equipment is not again regulated under TSCA. Per the EPA, transformers with a post-retrofill PCB concentration exceeding 25 ppm are most likely to creep back to ≥ 50 ppm [6].

Another common situation that presents a potential characterization pitfall concerns transformer bushings that are installed on retrofilled transformers. Bushings, sometimes called insulators, connect a transformer to a transmission device. They are the “arms” that reach from a transformer to the power transmission lines. The oil-containing chamber within a bushing is sealed and completely separated from the oil chamber (or tank) within the transformer. Because the oil chambers are not connected, the process of retrofilling a transformer typically did not include the bushings. While a transformer is in use, the attached bushings are considered to have the same PCB concentration as the transformer [7]. Once the bushings are removed from a transformer, the bushings must be managed based on their own PCB concentration. It is not uncommon for a transformer that has been retrofilled to a “Non-PCB” status, to have bushings installed which contain oil well above 50 ppm PCBs. Prior to disposing or “excessing” the bushings, it is important to test the oil inside them to determine the PCB concentration and applicable requirements.

A third potential characterization pitfall is overlooked equipment. In a large multi-facility site, it is possible that equipment with PCBs may have been overlooked during equipment inventories conducted after the passage of TSCA. Buildings and processes that were not in active use during the inventory process are most likely to contain overlooked PCB items. If a facility declared itself to be “Non-PCB”, D&D personnel could mistakenly assume that all oil-filled equipment within old, inactive buildings is Non-PCB. It is important to consult inventory records and PCB test results.

A fourth issue concerns PCB Articles contained within other items of equipment or machinery: PCB transformers or capacitors may be installed inside other equipment and be overlooked during the characterization process. Transformers and/or capacitors that contain PCBs are not exempt from TSCA regulation because they were placed inside other items.

Identification and Characterization of Non-Liquid PCBs (NLPCBs)

In comparison to their widespread use, NLPCBs have been poorly recognized. During development of the early PCB regulations, apparently very little information was provided to EPA concerning most NLPCBs. The "PCB Ban" was effective on July 2, 1979 [8]. The rule banned manufacturing of PCBs and the continued use all PCB materials that were not specifically authorized in the regulation. In the preamble to the rule, EPA summarized the results of ten days of public hearings conducted in 1978 concerning the proposed regulation. The notice indicated that NLPCBs were thought to exist only in few and limited applications, primarily as dyes and pigments; the associated PCB concentrations were thought to be relatively low. The notice indicated that representatives of the dye and pigment industry had objected to an immediate PCB ban due to the lack of available substitute products. As a result, a 30-month grandfathering period was established for the dyes and pigments to allow continued use of the PCB-containing products while industry developed Non-PCB alternatives. Other uses of NLPCBs apparently were overlooked during regulatory development. For example, the notice includes no information to indicate that manufacturers sought any grandfathering provision or use authorization for NLPCBs as plasticizers or in paints. Consequently, continued use of NLPCBs was banned by the 1979 TSCA regulation, even though the materials were applied or installed prior to the PCB ban.

In the post-TSCA era, NLPCBs were not generally recognized until the early 1990s, when the U. S. Navy discovered many NLPCB materials in its older submarines and surface ships. Shortly thereafter, DOE, the U.S. Air Force, and certain commercial nuclear facilities found NLPCB materials in use. NLPCBs were not generally recognized outside of those organizations until the mid to late 1990s, when EPA included information on them in Federal Register notices related to the 1998 PCB Disposal Amendments [4, 9]. However, NLPCBs still are considered an "emerging issue" by many in the regulated community. This is particularly true for organizations that do not closely monitor ongoing Federal and State regulatory development activities and associated issues.

Although information on NLPCBs is available in the public arena, it tends to be general in nature with the notable exception of data submitted to EPA in response to a request for data that the agency issued in 1999 [10]. EPA requested the data in an unsuccessful effort to develop a use authorization for NLPCBs. In response, fifty-eight documents were submitted to the EPA public docket [11]. On behalf of DOE, the author conducted a comprehensive review of all of the information submitted to the EPA public docket in response to the EPA data call. Some submittals included actual sample data collected by the responding parties [12, 13, 14]. Others included relevant excerpts from textbooks and journals from the 1930s – 1950s [15, 16]. The author subsequently has located additional information [17, 18] and has collected additional sample data on NLPCBs, primarily at SRS.

From the body of available information, one can discern definite NLPCB use patterns. Materials in which NLPCBs likely would be present include products formulated to have certain special properties. Those properties included: water resistance, fire resistance, flexibility, heat resistance, chemical resistance, and abrasion resistance. They usually were premium, specialty products that were relatively expensive. They were not generally used for routine applications where a less expensive alternative would suffice.

Table III contains a list of materials or products in which PCBs were used in order to achieve necessary performance levels with respect to the special properties described in the preceding paragraph. The PCBs used in these products were usually one or more of the commercial mixtures marketed by Monsanto Corporation as "Aroclors". Aroclor 1254 and Aroclor 1260 were used most frequently. The list is not all-inclusive, but shows the most prevalent NLPCB uses. NLPCBs were also used as adhesives, miscellaneous sealants, de-dusting agents, and in a variety of plastics.

Table III. Common Products that Potentially Contain NLPCBs

Product or Material	Property	Examples
Paints and Coatings	Waterproofing/Sealant	Containment basins for water; floor sealants; shower stalls, basement walls, concrete sealant, marine paints; pools
Paints and Coatings	Fire Resistance	Process Furnaces, Nuclear Fire Safety
Paints and Coatings	Chemical Resistance	Cranes used to lower items into corrosive solutions; surfaces regularly exposed to process or laboratory chemicals; surfaces treated to be acid-proof
Paints and Coatings	Heat Resistance	Equipment operating at high temperatures; room with a high temperature process; steam pipes
Paints and Coatings	Abrasion Resistance	Floor traveled by heavy equipment
Paints and Coatings	Flexibility	Chlorinated Rubber paints
Caulking and Joint Filler (particularly polysulfide or "Thiokol" rubber products)	Waterproofing/Sealant; Flexibility	Expansion joints; containment basins
Cable and Wire Insulation	Waterproofing; Flexibility, Heat Resistance, Chemical Resistance	Cables on ships and vessels; cables and wires used in thermally or chemically stressful environments
Rubber gaskets specified for high temperature service	Flexibility and Heat Resistance	Large facility/large air volume HVAC systems; equipment operating at high temperatures
Oil-impregnated felt gaskets specified for high temperature service	Flexibility and Heat Resistance	Large facility/large air volume HVAC systems; also used in Navy vessels
Rubber materials specified for stressful wet and/or high temperature environments	Waterproofing and fire resistance	Exposed rubber items used in ships and submarines
"Asbestos Protected Metal" Roofing and Siding Materials	Waterproofing	"Galbestos®" products manufactured by the H. H. Robertson Company

Characterization Pitfalls Related to NLPCBs

Several potential characterization pitfalls exist with respect to NLPCBs. The first pitfall is that information on various NLPCB uses is still relatively limited. This is particularly true outside of DOE, DoD, EPA and the commercial nuclear industry. Within DoD, the Navy has developed a strong knowledge base due to the widespread use of PCBs in its older ships and submarines. Within DOE most facilities and installations have developed, or are developing, programs for recognizing NLPCBs.

Based on the author's experience at SRS and interactions with colleagues in the regulated community, much work remains to be done to increase awareness of these PCB uses. However, awareness is much higher in 2007 than only a few years ago due to some well-publicized incidents concerning NLPCBs. Those incidents included the discovery of PCB caulking in schools and other buildings in the northeastern United States and the discovery of PCB coatings in a Denver-area public drinking water basin.

The second characterization pitfall involves the TSCA "Anti-Dilution Rule". The Anti-Dilution Rule is one of the primary tenets of the TSCA PCB regulations. The provision, contained in 40 CFR 761.1(b), prohibits the avoidance of any TSCA requirement as a result of dilution of the PCBs in or on an item. The rule effectively prohibits taking the mass of an object into account when determining its PCB concentration and regulatory status. Therefore, if a wall is coated with a paint containing a regulated concentration of PCBs, then the entire wall is considered to contain PCBs at that level and is subject to the TSCA storage and disposal regulations. Persons performing waste characterization tasks are more accustomed to the RCRA characterization approach, which uses an object's total mass to determine the concentration of RCRA "characteristically" hazardous constituents present in a waste. Because of the TSCA Anti-Dilution Rule, very large volumes of PCB wastes, e.g., painted concrete, wallboard, etc. can be generated from D&D activities.

The TSCA regulations do contain a few, very specific exceptions to the Anti-Dilution Rule. These are narrow and limited, but can provide significant regulatory relief under certain prescribed conditions. Project personnel are advised to consult with a TSCA PCB specialist to determine whether an exception to the Anti-Dilution Rule may apply in a given situation.

A third characterization pitfall concerns TSCA requirements for characterization of multi-phasic materials, i.e., materials or mixtures that can separate into distinct phases such as oil, water, and sediment. TSCA rules concerning multi-phasic materials may seem irrelevant to a discussion of non-liquid materials. However, an understanding of these requirements is important and directly related to issues that arise if NLPCBs migrate into other materials.

TSCA requirements for characterization of multi-phasic materials are driven by the Anti-Dilution Rule. TSCA requires each phase of a multi-phasic substance to be analyzed separately. The highest PCB concentration in a phase must then be assigned to all of the other phases. The material or waste may not be blended to obtain a temporarily uniform mixture for analysis. Nor may the analytical results for each separate phase be "averaged." A multi-phase waste must be disposed based on the highest PCB concentration found in any of the phases.

Alternatively TSCA does allow a generator to dispose each phase separately. If the phases are completely separated, each phase may be disposed based on its own PCB concentration and the TSCA requirements for the respective material and PCB concentration. For large volumes of waste, this can be a useful option.

Migration of NLPCBs into other materials poses a major characterization pitfall. Generally, NLPCBs are very stable materials. Once applied or installed, they tend to remain intact and securely in place for long periods of time. With respect to disposal, TSCA considers most NLPCB wastes to be "non-leaching" wastes that may be disposed in non-hazardous waste landfills with few conditions.

Unfortunately, under certain conditions, NLPCBs can migrate into other materials, such as liquids, or to accumulate in "unexpected" locations, such as sumps. Wastes generated as a result of D&D activities are particularly susceptible to migration of NLPCBs into other waste matrices. This susceptibility is due to the disruption and displacement of installed or applied materials that is inherent and essential to the D&D process. This is a significant characterization pitfall that should be considered during the D&D process. As examples, NLPCBs can migrate into other materials: if they are exposed to solvents or oils; if they are degraded, e.g., flaking; or if they are dissolved during laboratory analyses. In each of the cited examples, the new waste form frequently will consist of liquid and/or sludge materials which are regulated far more stringently than the source NLPCB form. For example, the debris from demolition of a concrete containment basin that was coated with PCB paint typically would be eligible for disposal in a non-hazardous waste landfill. However, if solvents or oils had been held in the basin in contact with the PCB painted surface, the PCBs may be drawn out of the coating into the solvent or oil. Depending on the particular set of circumstances and the PCB concentration in the liquid, TSCA regulations may require the liquid to be disposed at a TSCA-permitted incinerator.

When PCBs migrate into aqueous liquids, disposition can be even more challenging. PCB-contaminated water may not exceed 3 μg/L PCBs (approximately < 3 ppb) for disposal in a Clean Water Act-permitted wastewater facility that does not have a PCB limit in its permit [2]. Wastewaters with ≥ 3 μg/L PCBs may be discharged to a CWA facility if the facility permit includes a PCB limit and the wastewater meets that limit. TSCA also allows PCB wastewaters with < 3 μg/L PCBs to be released to navigable waters [2]; but 3 μg/L far exceeds the Clean Water Act (CWA) water quality criterion for PCBs, which is 0.000064 μg/L [19].

Alternatively, aqueous liquids containing PCBs may be decontaminated for re-use. Water must contain ≤ 0.5 µg/L PCBs (approximately ≤ 0.5 ppb) for unrestricted use [2]. For re-use in a closed, non-contact (by personnel) system with no releases, the water must contain < 200 µg/L PCBs (approximately < 200 ppb) [2]. These standards are of critical importance if an organization is considering any form of re-use or processing of liquids that are removed during the D&D process from vessels, sumps or other portions of a facility. For example, processing such removed liquids in order to recover valuable radionuclide or other materials can be done only if the liquids meet the applicable decontamination standard.

If it is not possible to disposition PCB-containing water in a manner specifically provided in the regulation, one may seek a risk-based approval from the EPA Region for an alternate approach. Approval of such requests usually takes from several weeks to several months depending upon the complexity of the request and the workload of the cognizant EPA personnel at the time the request is submitted.

SRS encountered several of these migration issues during a recent deactivation project. That project is the subject of the case study included in this paper.

Other Relevant Info Related to NLPCBs

It is important to understand that TSCA is proscriptive: TSCA only allows those activities specifically stated and approved rather than delineating the acts that are prohibited. Thus, unless TSCA regulations specifically state that one <u>may</u> do something, one <u>cannot</u> do it. The ban on PCB use and distribution in commerce impacts D&D projects as described in the following paragraphs.

TSCA banned all uses of PCBs except for those specifically named in the regulation. Similarly, unless specifically authorized under the TSCA PCB regulations at 40 CFR 761.20(c), any distribution in commerce of PCBs or PCB-containing materials is prohibited. Under TSCA, distribution in commerce includes selling an item or substance as well as other actions that impact commerce, such as donating or giving items away. The prohibition extends to holding or delivering items for others to introduce into commerce, except for purposes of disposal. None of the NLPCB materials listed in Table III are authorized uses of PCBs. That is, the NLPCB products and materials listed in the first column of Table III now must not contain PCBs. There is one exception: those items designated by EPA as "Excluded PCB Products"; covers materials coated with PCB paints < 50 ppm. If materials are unauthorized for use, they are also unauthorized for distribution in commerce for any reason other than disposal. Accordingly, when materials with NLPCBs are removed from service, generally they must be disposed. Unless they are decontaminated in accordance with the TSCA regulations, they are ineligible for recycle, donation, or sale as "surplus" or "excess" items.

NLPCBs applied to porous surfaces pose special challenges. As mentioned, TSCA regulations include provisions to decontaminate most equipment and materials. The regulation includes a variety of "self-implementing" methods for which no EPA approval is required. "Clean" thresholds are provided for a variety of materials. However, no methods or standards are provided for removal of NLPCBs such as paint from porous surfaces such as concrete. An EPA "alternate decontamination approval", similar to a permit, is required to remove or decontaminate NLPCBs from porous surfaces. Obtaining such an approval can be a lengthy process.

In SRS' experience, successful removal of PCB paint from a porous surface has been extremely difficult, time-consuming and expensive. Disposal of these and other NLPCB materials is much more cost-effective than removal of the PCBs. It is the SRS option of choice for all structures that can be physically removed from the building site during D&D activities.

However, some facilities have underground structures such as basements, vaults and sumps. If NLPCBs are present in or on these underground structures, they cannot simply be abandoned or ignored. There are two basic options in such instances. The first option is to decontaminate the structure. The second is to obtain EPA approval to dispose them in place in accordance with TSCA provisions that allow "risk-based disposal" of NLPCBs and/or PCB Remediation Waste (40 CFR 761.62(c) and 761.61(c), respectively). For SRS, the most effective approach has been to conduct the D&D activity as a CERCLA Non-Time Critical Removal Action in accordance with a 1995

DOE/EPA agreement for D&D of contaminated facilities [20]. Under that approach, the TSCA risk-based provisions may be cited as Applicable or Relevant and Appropriate Requirements (ARARs). Citing those ARARs, SRS has successfully proposed to EPA that certain NLPCB materials may be left in place. For perspective, it should be noted that NLPCBs usually are not the primary contaminants in these cases, and that protective actions such as capping or grouting normally are taken for the underground structure due to the other contaminants.

CASE STUDY: MISCHARACTERIZATION OF MATERIALS REMOVED FROM DEACTIVATED SUMP AT SAVANNAH RIVER SITE

Washington Savannah River Company (WSRC) is DOE's Management and Operating contractor for SRS. In June 2007, WSRC was informed by a vendor disposal company that an SRS bulk shipment of mixed waste solvent had not been properly identified and managed as PCB waste. WSRC recognized this as potentially non-compliant with TSCA manifesting requirements in 40 CFR 761.207(a)(1). The manifest identified the waste as hazardous for mercury under the Resource Conservation and Recovery Act (RCRA) regulations, but did not identify the waste as containing PCBs.

The waste shipment consisted of a Consani tanker with approximately 2600 gallons of mixed waste solvent that was shipped on April 30, 2007 from SRS to the vendor waste treatment facility in Oak Ridge, Tennessee. The vendor unloaded the waste into its feed tank. Subsequently, the vendor sampled the waste material and had it analyzed for a wide variety of constituents in accordance with its facility permit(s). The initial sampling identified PCBs at a concentration of 76 parts-per-million (ppm). The vendor collected a second sample and had another PCB analysis performed, which confirmed that the solvent was PCB-Contaminated. The vendor then notified WSRC that the waste material contained PCBs. The vendor facility which received the waste was not permitted to treat this form of PCB waste, nor had SRS intended to dispose PCBs at that facility.

Description of Waste Shipped to Vendor and Related Materials at SRS

Multi-phasic material: The Consani trailer of solvent waste contained one phase of a highly radioactive three-phase mixture. The mixture was removed in phases from a large (20,000 gallon) underground stainless steel sump located in the outdoor portion of a large chemical separations processing facility located in "F-Area" of SRS. The facility was undergoing deactivation. The sump, identified as the "Recycle Sump," had been used since the early 1950s to collect a variety of materials such as accumulated rainwater, raw materials leaks, and minor process leaks. The solvent in the sump was a material used in the chemical separations production process. The mixture included an aqueous phase and a sludge phase in addition to the solvent phase.

The sludge phase also had been determined to be waste upon its removal from the sump. It is believed that the sludge had accumulated for at least 20 years, and potentially throughout the approximately 50 years in which the facility produced nuclear materials. It had been characterized and managed as Transuranic Mixed Waste (hazardous for mercury). The sludge was packaged into 23 drums that subsequently were placed intact into six (6) "Standard Waste Boxes" for eventual shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The sludge was being stored in an SRS RCRA-permitted facility.

The aqueous phase had not been declared waste. Instead, it had been designated for re-use/processing in a similar SRS process facility located in "H-Area." Three hazardous materials trailers of the aqueous materials were in storage in F-Area awaiting transport to H-Area for re-use/processing.

Investigation revealed that the solvent and sludge phases had been analyzed for a wide variety of chemical and radiological constituents upon being declared waste. The sump materials were not analyzed for PCBs. Constituents selected for analysis were based upon "process knowledge", and PCBs were not among the chemicals that were ingredients in the facility's nuclear product. Furthermore, the sump itself was comprised of uncoated stainless steel and thus did not represent a PCB potential. The "process knowledge" characterization failed to identify the PCBs.

The most likely source(s) of the PCBs is considered to be NLPCBs that subsequently migrated into liquids that periodically were pumped into the underground sump. The large outdoor facility included numerous chemical and process tanks, which were installed in a large concrete apron with containment areas formed with concrete dikes.

The containment areas were used to capture any leaks from the chemical or process tanks. Leaked materials periodically were transferred to the sump. Construction specifications for the apron and diked areas prescribed the application of a special coating system typically used for its waterproofing and chemical resistance properties. Previous sampling of this coating system consistently had shown high concentrations of PCBs, e.g., exceeding 20,000 ppm. In addition, polysulfide rubber ("Thiokol rubber") caulking was used on the concrete apron. WSRC recently learned that PCBs often were used as the plasticizer in that type of caulking material. It is believed that the solvent material came into contact with some of the NLPCB material, possibly for an extended period, prior to being pumped into the sump. It should be noted that the process solvent ("PUREX") is closely related chemically to kerosene. Kerosene dissolves PCBs so effectively that it is an EPA-authorized decontamination fluid for PCB removal.

PCB characterization of the sludge and aqueous phases was then necessary. Because the materials were multi-phasic, additional sampling normally would be required to ascertain the PCB concentration and regulatory classification of the aqueous materials and the sludge. Due to the hazards associated with opening sealed containers of transuranic waste, SRS simply declared the sludge materials to contain PCBs at a concentration of ≥ 500 ppm. This was done with the approval of EPA Region IV and in accordance with an applicable provision in the TSCA regulation at 40 CFR 761.50(a) (5).

Samples of the aqueous liquids (water) in each of the three trailers were collected and analyzed for PCBs. As stated, plans had been made for the water to be re-used by processing in another SRS facility. Accordingly, the controlling TSCA standard for the water was the "unrestricted use" threshold of ≤ 0.5 μg/L PCBs. However, all of the water samples exceeded the 0.5 μg/L threshold. Therefore none of the water in the three trailers could be re-used in a processing facility, and the contents of all three trailers were declared to be waste. The contents of two of the three trailers subsequently were disposed in the SRS Effluent Treatment Facility in accordance with a provision in that facility's CWA permit. An additional thin layer of solvent material (regulated as PCB waste with the previously determined concentration of 76 ppm) was found in the third trailer. Safety and logistical issues precluded separating the solvent layer from the water in the third trailer. As a result, the entire contents of the third trailer were assigned a PCB concentration of 76 ppm in accordance with the Anti-Dilution Rule. The material in the third trailer must be disposed at the DOE TSCA Incinerator.

Corrective actions were required both at the vendor facility and at SRS. The SRS waste had to be removed from the vendor's feed tank, loaded into containers, and placed in TSCA-compliant storage pending eventual disposal at the DOE TSCA incinerator. The vendor tank then had to be decontaminated by triple-rinsing it with solvent in accordance with TSCA regulations. WSRC was, of course, obligated to reimburse the vendor for the expenses they incurred.

In addition to the steps required to clean the vendor's facility, other corrective actions were also required. In order to comply with the TSCA manifesting requirements, SRS had to provide the vendor with a corrected manifest. The SRS shipping container, along with two other trailers used during removal of the sump material, also required decontamination. Other required actions included labeling waste containers and correcting waste characterization documents. In an effort to preclude the occurrence of a similar event, WSRC conducted extensive "lessons learned" briefings for personnel involved with waste characterization, waste management, and environmental compliance.

The incremental costs of recovery from a characterization mistake of this type can be very high. WSRC estimates that an additional $425,000 of extra costs has been incurred. These costs include reimbursement of the vendor's expenses, decontamination of the SRS shipping trailers (performed by the vendor), purchase of specialized storage containers, and costs for expedited laboratory analyses. The figure does not include labor costs.

Fortunately, no enforcement action was taken by EPA, primarily because the error was caught <u>before</u> the solvent waste was treated by a facility that did not have an appropriate TSCA permit, and none of the water that was shown to contain > 0.5 μg/L PCBs was re-used/processed in the "sister" separations facility. Other positive factors that apparently helped to avert enforcement action included WSRC's prompt correction of the manifesting error and its quick assumption of responsibility for corrective actions at the vendor facility. In addition, SRS has a history of excellent TSCA compliance. However, it should be noted that the potential always exists for fines or other penalties in the event of non-compliance.

Lessons Learned

The most important lesson learned is that sampling is preferable to "process knowledge" characterization. In a D&D environment, extreme caution must be used when characterizing materials for PCBs (or any other constituent) using process knowledge. Process knowledge concerning the production of a material, i.e., the chemicals that were used to make a product, is not the same thing as knowledge of the facility's construction materials and how those materials can migrate. Major disruptions in a facility, whether during the deactivation phase or the decommissioning phase, may render historical data and assumptions obsolete. The sources of materials sent to sumps and other collection devices in old facilities should be evaluated carefully and specifically consider construction materials.

Another important lesson learned is that many disposal facilities analyze their customers' wastes upon receipt in order to ensure their own compliance with various permits or contracts. To avoid unpleasant and expensive surprises, a generator should analyze his waste in the same manner that the vendor will.

Yet another "lesson learned" is that project personnel need more knowledge concerning NLPCB uses, TSCA characterization requirements and the low thresholds at which some PCBs are regulated. PCBs, particularly in non-liquid forms, are far more prevalent than many waste management professionals have realized. Greater awareness is needed of their many uses and the extent to which NLPCBs may be present in a particular facility. Vigilance is needed to ensure that multi-phasic wastes are properly separated and analyzed in accordance with TSCA regulations and that the TSCA Anti-Dilution Rule is correctly applied to multi-phasic materials.

Since PCB use and processing is regulated, it is essential for facility personnel to be aware of the applicable requirements, especially with respect to water. Improper introduction of regulated PCBs into a process or inappropriate wastewater facility could have serious negative impacts. Impacts could include regulatory enforcement action with potential fines and penalties; shutdown of facilities pending acquisition of new or revised permits; and re-evaluation of facilities' safety and processing parameters.

WSRC periodically has issued general PCB guidance and characterization information as well as information specific to NLPCBs. For many years, WSRC has published a PCB Management Manual in which applicable TSCA requirements for characterization, use and disposal are explained in detail. The manual has been widely distributed to SRS environmental compliance and waste management professionals. However, WSRC has taken additional assertive steps to increase awareness of these PCB issues.

Based on the author's interactions with other members of the regulated community, the potential for similar problems is significant due to the relatively limited knowledge levels among many D&D and operations personnel. Organizations are urged to address this knowledge gap aggressively in order to reduce the chances of costly errors similar to those described in this paper.

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