Controlling Occupational Exposures to Historically Hazardous Materials

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Introduction

Building materials that included asbestos, lead, mercury, and polychlorinated biphenyls (PCBs) are generally believed to have been phased out and banned and are often not considered when analyzing potential occupational exposures. Some of these materials have not actually been banned, and even those that have been may still be present in existing building materials and equipment. Occupational exposures related to the presence of these materials and contact with them during repair, renovation, and routine operational activities is often poorly characterized and misunderstood. Further, governmental agencies involved in regulating these materials may apply differing rules and regulations that vary based on the material, its condition, or the specific activity being performed.

Between 2009 and 2010 we worked with a large municipal waste-water treatment bureau (the Bureau) to develop a strategy to characterize and manage exposures to these "legacy" materials. This bureau operates more than 20 waste-water treatment plants varying in age from 25 to 100 years. Each treatment plant consists of multiple buildings, miles of pipe, and an array of mechanical equipment. We were approached by the bureau after an initial exposure assessment and sampling strategy developed by the bureau was deemed to be too costly to implement.

The initial strategy consisted of extensive bulk sampling in an effort to create a database of the location of all materials containing asbestos, lead, mercury or PCBs (collectively the contaminants of concern or COCs) in the facilities. This initial plan called for the sampling of virtually all painted surfaces and suspected asbestos-containing materials regardless of condition or likelihood of contact or disturbance. This plan relied upon the assumption that the presence of these materials alone presents unacceptable risk to workers; however, the strategy did not assess the condition of materials and the activities performed on them, which are much more accurate indicators of exposure risk. Further, this strategy did not account for the fact that new products could still contain these COCs, nor did it address any new contaminants of concern that might be part of the new products.

We proposed an exposure management strategy based on the risk posed by these materials, using a variety of factors, not merely on their presence. Our approach to the exposure management strategy included the following steps:

- Walk-through surveys and meetings with management at a sample of the plants to determine the types of materials that were present, the condition of the materials, and the types of activities that might impact the materials.
- Analysis of regulatory guidance and scientific literature to determine when testing is required and which activities pose risk of exposure.
- Development of similar exposure groups and exposure activities to characterize exposure.
- Development of a strategy for the coordinated collection of a limited number of bulk samples and industrial hygiene exposure measurements which can be used to accurately quantify exposure and subsequent risk.

Our strategy determined that most materials potentially containing the COCs can be assumed to contain these contaminants and managed in place until such time as they are to be disturbed. The approach of managing materials in place allows sampling and abatement costs to be deferred over time without increasing risks.

Methods

In order to develop the sampling strategy, we based our approach on the American Industrial Hygiene Association AIHA Strategy for Assessing and Managing Occupational Exposures as well as other published literature (Paustenbach 2000, Ahrens & Stewart 2003, Smith et al. 2005, Ignacio & Bullock 2006, Viet et al. 2008, Keil et al. 2009). The general process for assessing and managing exposures is summarized in Figure 1 and involves:

- Gathering available information on the potential exposure including the specific occupational environment, the employees handling the material and their level of expertise, the task that involves that material, the expected time of exposure and the exposure pathway.
- Examining the potential exposures for similarities in the above mentioned factors and creating Similar Exposure Groups (SEGs).
- Prioritizing SEGs by examining past exposure assessments and by gathering information from related organizations that have previously conducted monitoring. This information can be used to determine the need for future exposure assessments, to fill data gaps and to assess the exposures of less frequent activities.
- Strategically performing exposure assessments where it is determined that there is the potential for exposure, a lack of sufficient data or the existing data is no longer applicable.
- Grouping results into three basic categories - acceptable exposure, uncertain and unacceptable exposures. Acceptable exposures require no additional action until processes change significantly; however, these exposures should be routinely re-visited to determine if variations from the initial assessment have occurred. Unacceptable exposures require control implementation; the type of control will vary based on the frequency and nature of the task involved. Uncertain exposures require additional information gathering. Whether it is information on the task or the material behavior during that task, these exposures require

additional scrutiny to determine how to resolve the exposure question.

- Documenting and disbursing information in an accessible format for affected employees.
- Repeating this process for all new exposure activities as well as those processes that experience a significant change in nature. The exposure assessment strategy is a never-ending path that continues to allow refinement of exposure understanding and more effective control implementation overall.

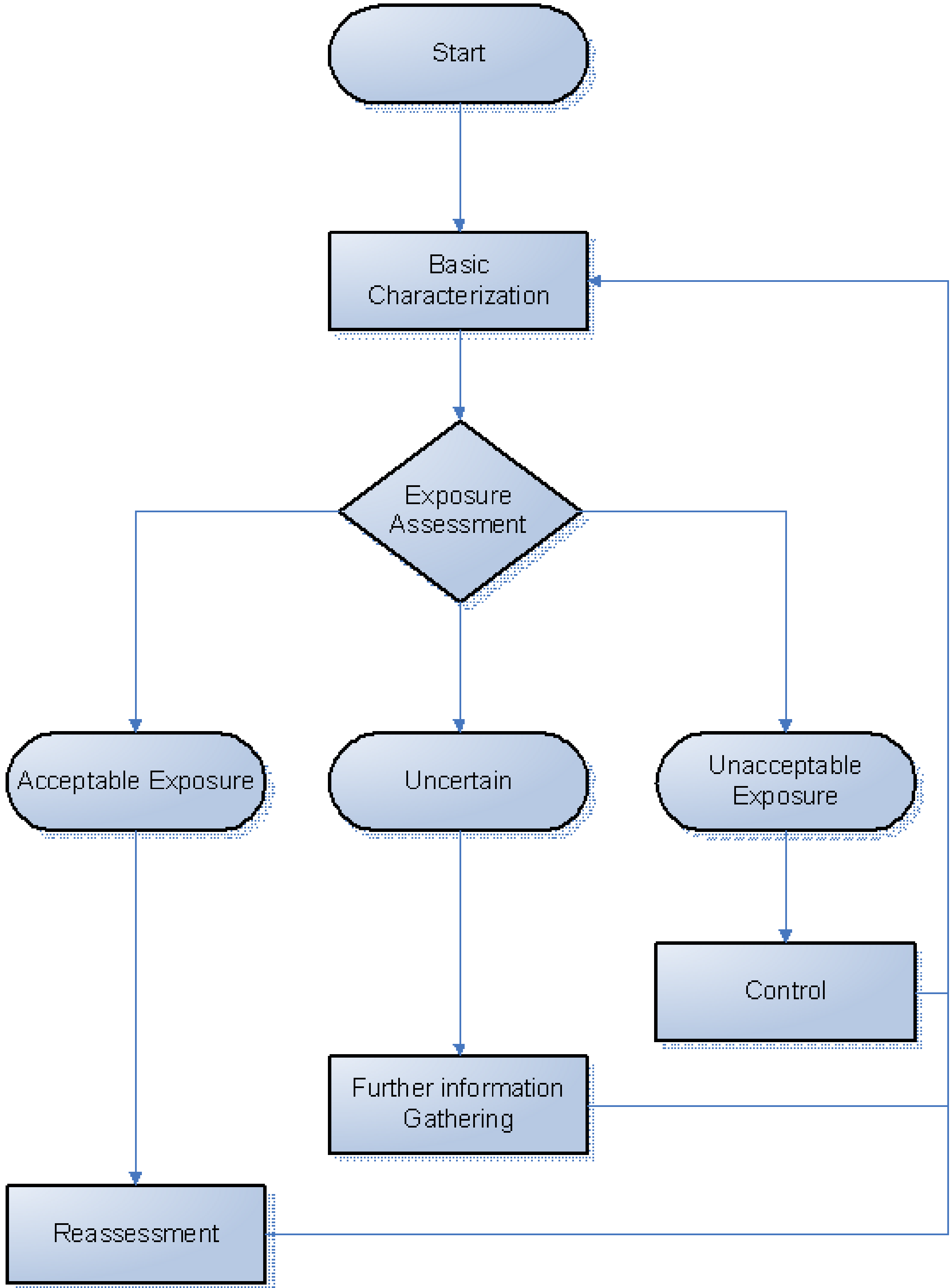

Figure 1. General methodology for assessing occupational exposures.

In order to gather the information required to develop the exposure assessment strategy, we visited a sample (approximately 50%) of the waste-water treatment plants operated by the Bureau. We interviewed staff of various levels and job titles as to their work activities, how often they performed those activities with the possibility of encountering COC-containing materials, and what methodology they used when performing this work. We also reviewed existing bureau documentation including standard operating procedures, policy documents, existing sampling results, and abatement reports.

We identified two primary exposure groups, both with limited potential for occupational exposures during typical work tasks. The first group included electricians, machinists, sewage treatment workers, and senior sewage treatment workers. The second group had no, or extremely limited, exposure potential and included instrument specialists, oilers, engineers, and senior engineers. It was not believed that office and administrative workers had any significant exposure potential to any COC-containing material.

Existing sample results and a review the available literature on the handling of the COC-containing materials was utilized to characterize the expected exposure levels associated with the work activities identified. Additionally, we characterized activities that we identified that workers may perform in the future, but are currently prohibited due to internal policies or training and regulatory requirements.

Results

Asbestos

Asbestos was determined to be potentially associated with plant equipment in the form of gaskets, packing, pipe insulation, electrical wire insulation, electrical panels, and other materials. Asbestos may also be present in building materials including floor tile, window caulk, wall mastic, fireproofing, and roofing materials. Asbestos-containing material (ACM) has previously been found hidden behind other materials such as walls and floors at the treatment plants. The plants did possess some records for bulk sampling of ACM at their facilities; however, the management and organization of the sample results was not consistent across the facilities. Further, the record keeping did not capture samples collected by outside contractors or other governmental agencies. There was also no method for tracking which confirmed ACMs had been removed.

Generally, it was reported that workers and contractors did not intentionally disturb any suspect materials until the materials have been tested and confirmed to be non-ACM. Local regulations require that anyone who handled ACM be appropriately trained. At the time of this work, the Bureau employed three electricians who held the proper credentials to handle ACM; however, these workers reported that they did not disturb ACM as part of their work, but were utilized to provide electrical assistance during the sampling or abatement of suspect ACMs associated with electrical equipment.

Although there was no intentional disturbance of ACM, many of the sites indicated that workers may inadvertently contact ACM in the form of gaskets during the repair and maintenance of equipment and pipes. Also, ACM may inadvertently be contacted during preventative maintenance and repair of electrical systems. It was reported that operators may open electrical cabinets, visually inspect for damage, and change fuses. During this work they will not disturb any ACMs that may be present in electrical cabinets. Historically operators may have blown out, vacuumed, and/or wiped settled dust from the interior of electrical cabinets. Electricians may perform more disruptive work inside electrical cabinets, including tightening of contacts, removal of components, stripping and cutting of wire, as well as vacuuming, wiping, or blowing out settled dusts. At the time of this assessment electricians did not perform any activities inside cabinets which may involve presumed asbestos containing material (PACM) without prior sampling and abatement if necessary.

Asbestos exposure in the workplace is regulated by OSHA in the general industry under standard 29 C.F.R. 1910.1001 and the construction industry 29 C.F.R. 1926.1101. OSHA has established a permissible exposure limit (PEL) of 0.1 fibers per cubic centimeter of air (f/cc) and an excursion limit of 1.0 f/cc over a 30 minute period. Both the general industry and construction standards require that an initial exposure determination be performed for any activities with potential exposure to asbestos (OSHA 1994a, OSHA 1994b).

Although workers do not routinely or intentionally disturb asbestos-containing materials, there is the potential that workers may unknowingly disturb asbestos-containing gasket material during repairs, maintenance, or emergency responses. Generally gaskets are not accessible until such time as a flange is broken and the material is disturbed; thus bulk sampling prior to replacement is not typically feasible. The exposures associated with the removal of gasket material that have been published in the peer-reviewed literature are presented in Table 1 below (Cheng & McDermott 1991, McKinnery & Moore 1991, Spence & Rocchi 1996, Longo 2002, Boelter 2002, Mangold 2006, Madl 2007). The bureau’s existing policy is that if workers encounter gaskets that were previously inaccessible and that after exposing the material they believe it to be asbestos containing; they would stop work and wait for testing of the material before performing any additional work. In assessing this limited duration exposure scenario, we considered the reported exposure magnitudes provided in the scientific literature and the short time associated with any exposure associated with opening a flange initially, and it is our opinion that such a situation would be highly unlikely to result in exposures above any regulatory guidance.

Author	**Reported Exposures**	**Notes**
US Navy (1978) *unpublished cited in Madl et al.	Reported average levels ranging from <0.05 to 0.13 f/cc. Reported range of <0.03 to 0.39 f/cc.	Short duration samples. Sample times not specified. Work performed aboard a naval vessel.
Cheng & McDermott (1991)	Reported range of 0.11 to 1.4 f/cc.	Short duration samples. Sample times not specified.
McKinnery & Moore (1991)	Average levels of 0.24 f/cc with a reported range of 0.05 to 0.44f/cc.	Short duration samples. Sample times not specified.
Spence & Rocchi	Reported a maximum TWA level of	Exposures reported as 8 hour

(1996)	0.005 f/cc.	TWA exposures. Used a wet method not typical in the United States.
Spencer & Balzer (1998) *summary of 3 unpublished studies from Madl et al.	Reported TWA exposures with a range of <0.045 to 0.008 f/cc.	Exposures reported as 8 hour TWA exposures.
Longo et al (2002)	Reported an average task based exposure of 21.8 f/cc with a range of 9.3 to 31 f/cc. Reported TWA exposures of 2.3 to 3.6 f/cc.	Reported both task based and TWA exposure measurements.
Boelter et al (2002)	Reported average TWA exposures of 0.014 f/cc with a range of 0.00 to 0.035 f/cc.	Exposures reported as 8 hour TWA exposures
Mangold (2006)	Reported average TWA exposures of 0.03 f/cc with a range of 0.01 to 0.08 f/cc.	Exposures reported as 8 hour TWA exposures

Table 1. Asbestos exposures associated with gasket removal activities.

There have been some limited studies of asbestos exposures during electrical maintenance activities (Mylnarek 1996, Millette 1999, Williams 2007). The exposure ranges reported in these studies are presented below in Table 2. These studies indicate that the potential exposures associated with electrical repair work are below the current OSHA PEL. These studies, however, were limited and did not capture all of the activities that the employees may have historically performed. Any work tasks to be performed in the future would require an exposure assessment of the type detailed in the Discussion section of this paper.

Activity	Exposure Level	Sample Type	Reference
Wire Stripping	One detection at 0.11f/cc, the remaining samples were below the detection limits; however, detection limits were above the PEL.	Short term (30 minute) samples	Millette 1999
Cutting and Stripping Wire	0.006 f/cc	Short term, 2 hour samples	Maxim Engineers 1990*
Cutting and Stripping Electrical Cable	<0.007 to 0.073 f/cc	8 hour TWA samples	Clayton 1994*
Cable Splicing	<0.011 to 0.073 f/cc	Short term 20 to 30	Soule & Masaitis 1997*

Activity	Exposure Level	Sample Type	Reference
		minute samples	
Electrical Repairs	0.0034 to 0.052 f/cc	8 hour TWA samples	Mlynarek et al 1996
*Unpublished study. Results are as presented in Williams et. al 2007			

Table 2. Exposures Associated with Various Electrical Maintenance Activities.

Lead

We identified that lead was potentially present in paint, solder, or electrical equipment. The most likely lead-containing material to be encountered employees was lead-containing paint. We do not use the term lead-based paint (LBP) (defined as paint or other surface coatings that contain lead equal to or exceeding 1.0 milligram per square centimeter or 0.5 percent by weight) as this does not represent a meaningful threshold when analyzing occupational exposures. OSHA has issued multiple letters of interpretation that address the issue of bulk sampling and its poor correlation with exposure. (Hillenbrand 1981, Fairfax 1999, Fairfax 2000, McNully 2003, Fairfax 2008). Lead-containing paint may be present on building components as well as plant equipment such as pipes, pumps, valves, and tanks. The plants had some existing data on the concentration of lead in paints obtained by bulk sampling or non-destructive (XRF) methodology. This data was typically collected in relation to a renovation or repair project and most plants indicated that they tested paint prior to disturbance.

It was reported that some sites utilized “bridge painters” to perform painting during the winter months. Although lead was banned in residential paints in 1978, this ban does not apply to non-residential uses such as waste-water treatment plants (National Cooperative Highway Research Program 1997). Typical levels of lead in bridge paint range from 10% to 50% lead by weight (National Cooperative Highway Research Program 1997). It was not confirmed nor denied that the bridge painters used bridge paints; however, given the nature of the structures that required coatings (pipes, towers, etc) it is possible that these industrial coatings would be similar to bridge paints and may have contained lead (National Cooperative Highway Research Program 1997). The existing lead management policy for the plants allowed for the application of lead-based paints in areas where no feasible alternative exists.

There was an existing management policy for lead-based paint at the plants which allowed employees to perform a specific set of activities with low risk for lead exposure exceeding the action level (AL). These activities included repainting with no surface preparation, window pane replacement, door repair, electrical fixture repair, activities that disturb less than two square feet of paint (except dry scraping) and chemical paint removal with non-methylene chloride paint remover. The existing policy also defined guidelines for lead abatement activities performed by outside contractors. Typical paint disturbing activities performed by plant personnel include drilling of holes to mount equipment, cutting of pipes, and the removal of bolts on painted pipes and equipment.

It was generally reported that if paint was found to be lead-based, workers used a chemical stripper or contacted an outside contractor to remove the paint in the area that will be disturbed. One site, however, indicated that they were not aware of lead paint issues, did not test paint, and did not have chemical strippers on site. This site also indicated that they sometimes torch cut bolts, which maybe coated with paint.

Lead exposure in the workplace is regulated by OSHA in the general industry lead standard 29 C.F.R. 1910.1025 and the construction industry 29 C.F.R. 1926.62. There is no guidance on the collection of bulk samples in the OSHA regulations. In the lead standard, OSHA has established a PEL of 50 micrograms of lead per cubic meter of air ($\mu g/m^3$) and an AL of 30 $\mu g/m^3$. Both the general industry and construction standards require that an initial exposure determination be performed for any activities with potential exposure to lead to determine if exposures are above the AL or PEL. The construction standard defines exposure levels which must be assumed for specific activities until such time as an initial exposure determination has been performed (Table 3) (OSHA 1978a, OSHA 1978b).

Exposure Range		
> 50 to 500 $\mu g/m^3$	**> 500 $\mu g/m^3$ to 2,500 $\mu g/m^3$**	**> 2,500 $\mu g/m^3$**
• Manual demolition • Dry manual scraping • Dry manual sanding • Heat gun use • Power tool cleaning with dust collection systems • Spray painting with lead paint	• Using lead-containing mortar • Lead burning • Rivet busting • Power tool cleaning without dust collection systems • Cleanup of dry expendable abrasive blasting jobs • Abrasive blasting enclosure movement and removal	• Abrasive blasting • Welding • Torch cutting • Torch burning

Table 3. Presumed 8-Hour TWA exposure levels for lead-related construction tasks.

Based on the nature of the work that might be performed by the workers, an initial exposure determination was proposed that involves the collection of IH exposure measurement data from a representative group of employees. If the exposure measurements reveal exposures below the AL, no further action is required until there is a change in the work process. If exposure levels are greater than the AL, but less than the PEL, exposure monitoring must continue every 6 months until two consecutive rounds of sampling, separated by more than a week, reveal exposures below the AL. For exposures greater than the PEL, exposure monitoring must continue every 3 months until two consecutive rounds of sampling, separated by more than a week, reveal exposures below the PEL or AL. If the exposure measurements are below the PEL, but above the AL monitoring frequency is reduced to every 6 months; if the measurements are below the AL no further action is required until there is a change in the work process. A summary of the exposure determination process is provided in Figure 2.

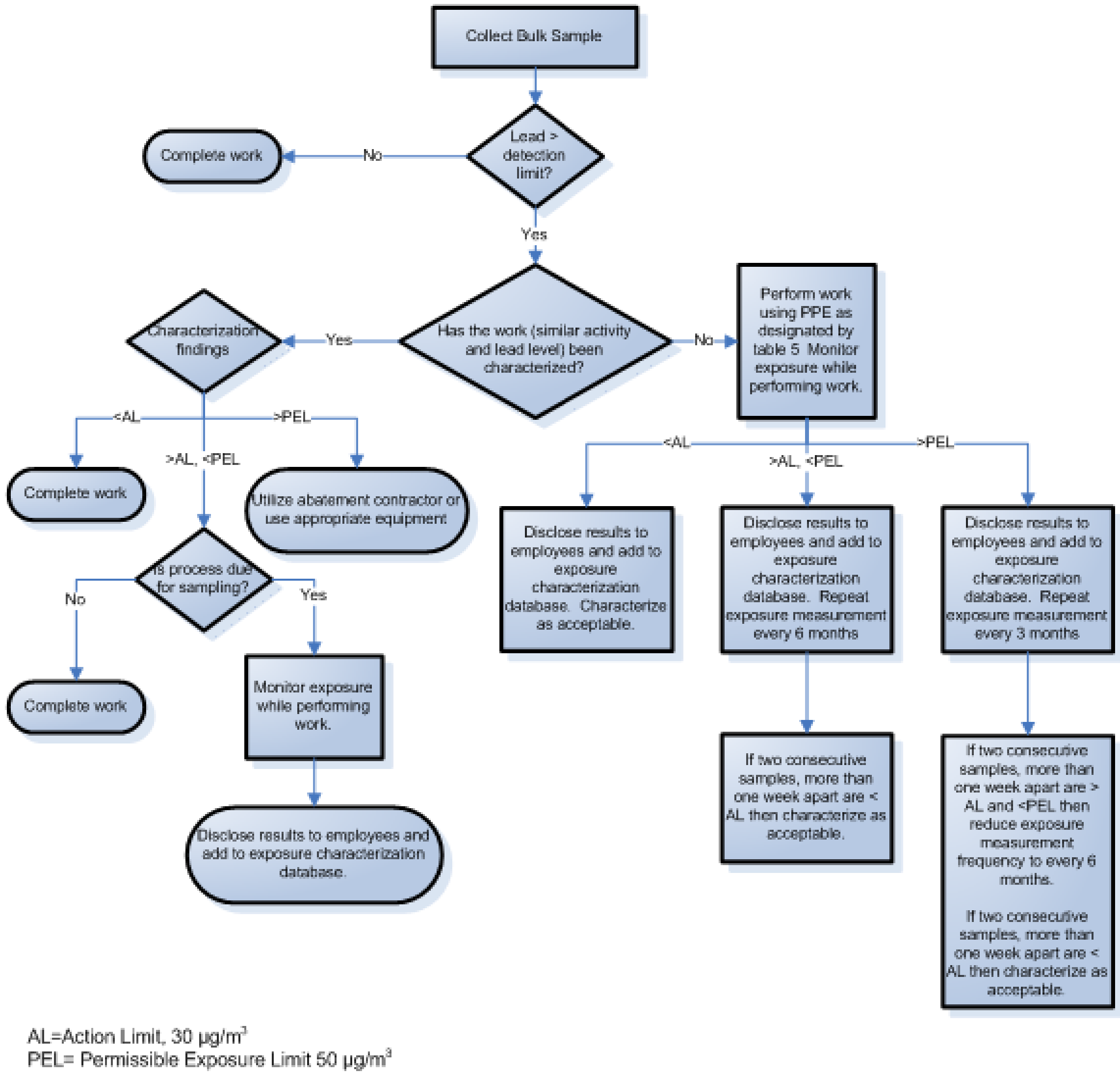

Figure 2. Exposure assessment process for lead-containing materials.

The exposure levels associated with various Lead-Based Paint activities have been reported in multiple sources. Additionally, OSHA provides default exposure assumptions for specific activities to be used until such time as an exposure assessment has been established, which have been summarized in Table 3 above. A summary of reported exposure measurements associated with work that may be performed by employees or contractors operating at plants are provided in Table 4 (National Cooperative Highway Research Program 1997, NIOSH 1997). It should be noted that the values presented assume that the work activities occur for a full 8-hour day; work performed by employees are typically small scale and short duration and would result in lower TWA exposures than those presented in the table.

Table 4: Reported Exposures Associated with Lead-Based Paint Removal		
Activity	Range of Exposure (μg/m^3)	
	Typical (median)	Maximum
Open abrasive blasting	17,300	59,000
Contained blasting	25,700	59,000
Welding/cutting/burning	600	28,000
Hand scraping	45	167
Chemical stripping	11	476
Power tool use	735	20,066
Enclosure movement	500	2,100
Miscellaneous rehabilitation	45	41,000

Table 4. Reported exposures associated with lead-based paint removal activities.

Mercury

We identified that mercury containing materials at the plants may include paint, pressure switches, thermostats, thermometers, fluorescent light bulbs, and floats. Plants had an inventory of all pressure switches, thermostats, thermometers, and floats that contained mercury at their sites. There was no tracking of mercury in paint, but was tested for mercury prior to any disturbance. Standard policy at the plants was to handle mercury-containing materials other than paint as universal waste.

Plant employees were unlikely to disturb mercury containing materials in any significant manner. Paint was tested for mercury content prior to disturbance and if paint contained mercury it was handled by an outside contractor. Mercury containing devices such as bulbs and switches do not represent a potential exposure during normal handling. It was reported that in the event a mercury containing device was broken the area would be barricaded, an outside cleanup contractor was engaged and air monitoring for mercury vapors would occur.

OSHA regulates mercury exposure in the workplace in general industry under 29CFR1910.1000 Table Z2. In the mercury standard OSHA has established a PEL of 0.01 mg/m^3. The standard requires that an initial exposure determination be performed for any activity with potential exposure to mercury to determine if exposures exceed the PEL (OSHA 2006). Based on the activities currently performed by personnel there was no reason to believe that employees would be exposed to mercury above the PEL.

Polychlorinated Biphenyls

PCBs were identified to be potentially present in paint, transformer oil, light ballasts, concrete, and caulk. When PCBs were present in transformer oil, they were labeled accordingly. PCBs in paint were sampled along with metals (including lead and mercury) any time paint was to be disturbed. None of the facilities indicated that they typically sampled caulk for PCBs, although some of them were aware of asbestos being present in window caulk at their facility. PCBs have been discovered in contaminated concrete at some sites.

PCBs are regulated by the USEPA under the Toxic Substances Control Act. There is no regulatory requirement for bulk sampling of paint and caulk. If caulk is sampled and has PCB content >50ppm it is considered an unauthorized use and must be removed and decontaminated. It is not clear that "in use" paint requires immediate removal (US EPA 1999). It should be noted that the regulation of PCB containing materials is an emerging issue and there has been increasing pressure on federal, state and local governments to regulate PCB containing materials found in building materials. Recently New York City has instituted a plan to remove PCB containing light ballasts from public schools. (Navarro 2011)

OSHA does not have a standard specific to PCBs, but does have a PEL for Chlorodiphenyl, (42% chlorine PCB) of 1 mg/m^3 (1,000 $\mu g/m^3$) and Chlorodiphenyl, (54% chlorine PCB) of 0.5 mg/m^3 (500 $\mu g/m^3$) (OSHA 2006). OSHA also has issued a letter of interpretation stating that exposure to other PCB congers should be addressed consistent with the existing PELs citing the general duty clause. The ACGIH TLVs for PCB exposure are identical to the OHSA PELs.

There was no existing industrial hygiene sampling results for PCBs specific to any of the treatment plants. The exposures associated with the presence of PCBs in building materials is an emerging issue and there is limited data available about potential exposures in the scientific literature.

The potential for exposure associated with PCB containing caulk has been measured in some studies. A majority of the studies looked at biomarkers of exposures, but a few measured the concentration of PCBs in air. These studies reported air concentrations ranging from 111 to 393ng/m^3 (0.111 to 0.393$\mu g/m^3$) associated with the presence of PCB containing caulk (some of which was dried and cracking) and up to 120 $\mu g/m^3$ associated with the removal of caulk (Sundahl 1999, Herrick 2004, Kontsas 2004). The results of these studies indicate that the presence and removal of caulk would be unlikely to result in exposures greater than the PEL or TLV; however, based on the limited availability of data we recommended that samples be collected, at a minimum during removal activities, the better characterize the range of expected exposures.

We were unable to identify any measurements of exposure to occupants of buildings with PCB containing paint or among workers removing PCB containing paint. The Washington Department of Health has used an emissions model to estimate PCB concentrations in air associated with PCB containing paint and paint debris on the exterior of a building. This model is not generally applicable to indoor or occupational settings; however, it did suggest that exposures would be below the PEL (Washington State Department of Health 2010).

It is generally recognized that the standard handling of PCB light ballasts and the presence of PCB contamination in transformer oil does not present a significant exposure hazard. NIOSH has performed a Health Hazard Analysis (HHE) in a school building with burned out PCB light ballasts and did not find any unacceptable exposures (NIOSH 2009).

Discussion

We found that although in-place materials have potential for exposure during disturbance, they generally did not result in significant exposures when undisturbed; that is the mere presence of these materials will not trigger occupational exposures that would be of concern to workers or occupants. Large scale surveying of materials for contaminants was found to be extremely costly and unlikely reduce any de minimis risk of exposure. Dependent on local regulatory handling requirements and waste disposal regulations for the specific materials, broad-based bulk sampling was generally found to be unwarranted. A strategy utilizing a combination of targeted bulk sampling and task-based exposure monitoring was the most efficient method of reducing risk to workers.

Asbestos

Intact ACM presents no exposure hazard until such time as it is intentionally disturbed; it degrades or is damaged, or is subjected to conditions that could lead to fiber release. The following recommendations were developed assess and document potential exposures to asbestos-containing materials:

- ACM and PACM should be appropriately labeled for easy identification by employees. Suspect materials should be visually assessed regularly to insure that they are not damaged or degraded, consistent with in-place management practices recommended by the USEPA (Cite).
- Materials that are tested and confirmed as not containing ACM should be labeled as non-ACM, catalogued in a database as sampled with a negative outcome. Further, a system should be developed to label or otherwise identify where new, non-asbestos-containing, materials have been installed in a system. Such systems must be constantly maintained and updated to assure that information is current and useful to decision makers and workers.
- Although employees did not intentionally disturb any ACM, if workers were to begin performing such work, we recommended that an exposure assessment be performed for each material/activity combination to determine the level of protection required or the need for outside contractor assistance.

Lead

Intact lead based paint presents no exposure hazard until such time as it is disturbed (8). In the absence of contrary information, intact paint should be presumed to be lead containing until such time as it will be disturbed and managed in-place. The following recommendations should be considered to assess and document potential exposures to lead-containing materials:

- Chipping, peeling and cracking paint presents minimal exposure potential in the absence of an activity that will potentially result in dust generation (wind erosion, vibration, friction, etc.). If areas with damaged paint and potential for dust generation are identified it was recommended that the paint be tested to determine lead content and if the paint is lead containing then industrial hygiene air samples of either the area, or workers who work in the area be collected to establish a baseline exposure.
- For any activities involving the disturbance of paint known to be lead containing initial exposure determinations consistent with the OSHA lead standards should be established. These exposure determinations should be catalogued in a central location and consulted for future activities.
- Further, it should be required that contractors provide MSDS for all new coatings being applied to ensure that new lead-containing is not being applied. No new LBP should be used unless there is no feasible alternative available.

Mercury

Mercury contained within devices or in undamaged paint presents no exposure hazard until containment is breached or paint is intentionally disturbed, degrades or is damaged. The following recommendations should be considered to control and document potential exposures to mercury-containing materials:

- Materials that are tested and confirmed as not containing mercury should be catalogued in the database as sampled with negative outcome.
- Damaged mercury-containing paint presents minimal exposure hazard, but should be managed in-place, as recommended for lead containing paints.
- Until such time as mercury-containing devices are eliminated from the workplace, the employees should be trained in the mercury spill procedure on an annual basis at a minimum.

Polychlorinated Biphenyls

Based on the lack of reliable data we recommended that an exposure measurement process to determine the potential exposure associated with the presence of PCB containing paints be implemented. We recommended that wipe samples[1] be collected from up to 10 locations in each plant where deteriorated paint is present. If results indicate the presence of PCBs above $10\mu g/100cm^2$ then area exposure monitoring air[2] samples would be collected for comparison to occupational exposure standards. If the industrial hygiene sample results indicate exposures greater than PEL then personal sampling should be performed, if personal samples are above the PEL a more extensive survey and abatement program should be considered. The process of estimating exposures associated with the presence of PCB containing paints is presented in Figure 3. We believed that exposures in areas with deteriorated paint will not exceed exposure

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[1] USEPA has stated that if PCBs have not significantly migrated to the surface of paint that it is assumed that they will not be present in the air (US EPA 1999). The analytical methodology for wipe samples can be found in 40 C.F.R. Part 721

[2] Air samples should be collected in accordance with NIOSH method 5503

guidelines; however, based on the lack of quantitative data on exposure, the prudent action is to measure exposure before deciding on appropriate action.

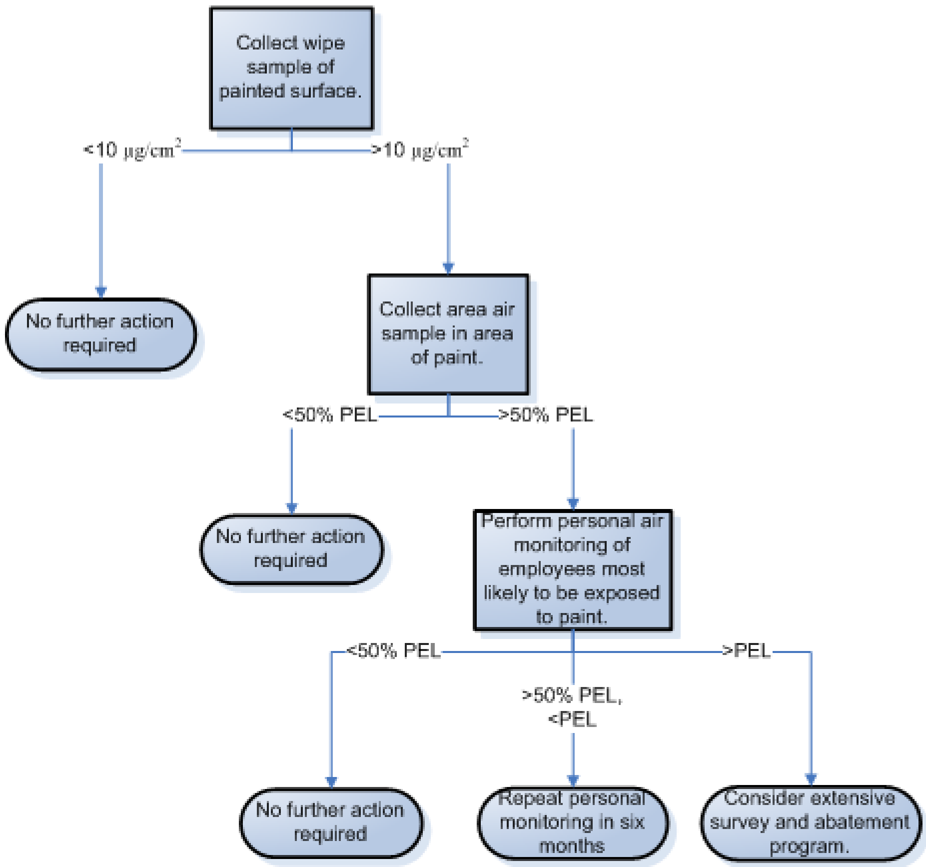

Figure 3. Exposure assessment process for PCB-containing paint.

The existing scientific literature does not indicate that the presence of PCB-containing caulk, even when in compromised condition leads to exposures above occupational exposure limits. Anytime that paint or caulk is to be removed it should be tested for the presence of PCBs. Although there is no regulatory driver for the bulk sampling of PCBs, the use of dust generating work practices has the potential to result in exposure to employees.

The potential for exposure associated with materials contaminated with PCBs due to historical spills should be evaluated on a case by case basis. The size of the spill, likelihood of contact and activities occurring on or around the material should be taken into account when considering potential exposures.

Conclusion

From this assessment process, we determined that the potential risks associated with in-place materials containing asbestos, lead, mercury and PCBs presented little risk to occupants and workers when not disturbed. The wide-scale testing of such materials would provide little risk reduction and that the most effective method to handle these materials would be an in-place management protocol that would involve bulk sampling and air monitoring only when activities would impact these materials. Although this may not be the most efficient method for every workplace (such as small individual locations), we believe this process would nonetheless be effective in controlling exposure. This process also highlighted the difficulties in tracking bulk sample results and linking them to specific locations in large, multi-site work environments.

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