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WASTE CLASSIFICATION GUIDANCE FOR BUILDING DEMOLITION DEBRIS CONTAINING LEAD BASED PAINT

PURPOSE: This guidance provides two different acceptable methods for the characterization of the solid waste generated during demolition operations through sampling and Toxicity Characteristic Leaching Procedure (TCLP) analyses. Using either method, demolition debris can be characterized as hazardous or non-hazardous waste as defined by RCRA. These methods apply to demolition debris only and do not apply to heavy metal bearing wastestreams that are generated from other specific operations (e.g., paint scrapings, sandblast residues, etc.). Throughout this document, lead contamination, the most common TCLP debris concern, is used as an example, although these methods can be used to classify other TCLP wastes as well.

METHODS: Method I- The Sampling/Statistical Analyses Method requires sampling and TCLP analyses of both the paint and building material. The data is analyzed using conventional statistical methods to transform the results to a confidence interval (CI) of 80%. Method II- The Mass Balance TCLP Method requires only sampling and TCLP analyses of the paint and adjusts the TCLP data by a factor based the calculated uncontaminated mass in the total debris.

Method I. Sampling/Statistical Analyses:

SCOPE:

a. Before characterizing the waste, it is necessary to define the wastestream. The wastestream is the debris generated during a given demolition project at a given site/installation. While all buildings/structures generating demolition debris constitute the wastestream, only a percentage of these buildings need be sampled. Details on how to determine the appropriate number of buildings to sample are presented in the "PROCEDURE" section below.

PROCEDURE: During demolition debris waste characterization, several site-specific determinations need to be made. The following steps explain how:

a. Defining Individual Wastestreams/Populations: As defined above, the wastestream consists of all the debris generated during a specified demolition project. A list of the buildings should be recorded, including the building components undergoing demolition , and notations of buildings that will be generating the same type of debris because they are the same or similar design and construction and are undergoing the same type of demolition or rehabilitation. Information should also be gathered regarding the demolition and disposal procedures.

For instance, if the structures are set on cement foundations it would be necessary to determine whether the cement is to be demolished and disposed of with the rest of the debris. If such foundations were to be left in place they would not be considered as debris; otherwise, they would be included in the wastestream and would be sampled in accordance with the procedures discussed below.

b. Determining the number of Samples: Based on EPA guidance (EPA/600/8-89/046, March 1989, Soil Sampling Quality Assurance User's Guide, 2nd Edition), a statistical approach will be used to determine the number of buildings that need to be sampled. This approach is based on the assumption that the buildings are all relatively uniform and that the analytical results of the study will be normally distributed. The EPA manual SW-846--Test Methods for Evaluating Solid Wastes, Section 9.1.1.3, Basic Sampling Strategies (Attachment A), requires that the number of samples used to characterize a wastestream ensure an 80 percent confidence level in the resulting determination (in this case, hazardous or nonhazardous waste determination). The enclosed Table 1 is based on these guidelines and should be used to determine the number of buildings to be sampled at a given project site.

c. Sample Buildings Selection: Once the number of buildings to be sampled has been determined, the specific buildings to be sampled need to be identified. For buildings generating identical or similar debris (made of the same construction materials and painted with the same paint) a random approach should be used in the selection process. Buildings may be randomly selected using building numbers or placement on maps. However, when one or more groups of buildings generating identical or similar debris constitutes a separate and distinct segment within the total number of buildings, an appropriate percentage of buildings should be selected from the individual group(s).

d. Sampling Strategy: The objective is to obtain one representative composite sample from the debris wastestream from each building selected for sampling. The composite sample must include appropriate proportions of each debris that the wastestream is made of. Figure 1 depicts various areas of a building that may be constructed of different materials and must be sampled if they are part of the debris wastestream. Areas that will not be part of the debris wastestream do not have to be sampled.

(1) Debris components, such as glass, screen, or wiring, that are difficult to sample and comprise a very small (de minimis) percentage of the debris wastestream, do not have to be sampled. Also materials such as aluminum siding, large metal ductwork, light ballasts, utility equipment, and asbestos insulation need not be sampled if these materials are separated from the demolition debris and recycled/reused (e.g., scrap metal). In general, the most commonly sampled components will be wood, brick, cement and plaster/wallboard.

TABLE 1- STATISTICAL DETERMINATION OF THE NUMBER OF BUILDINGS TO BE SAMPLED

NO. OF TOTAL BUILDINGS AT ONE PROJECT SITE	NO. OF BUILDINGS TO SAMPLE*
1 - 9	ALL
11 - 15	10
16 - 20	13
21 - 30	16
31 - 40	21
41 - 100	26
> 100	32

* It should be noted that a sample is defined as a composite of subsamples from one building. 20-30 subsamples should be sufficient to make one sample.

2) The proportional size of the various building debris components based on (estimated) square footage must be determined. For instance, a building may be 70 feet long, 40 feet wide and 12 feet high; if all four of the exterior walls are to be demolished and are made of the same material, there is 2640 ft^2 of that debris component. Window and door space should be subtracted out from the exterior-interior walls and considered as separate debris components. The estimated area of each debris component (e.g., exterior wall, interior plaster board wall, interior plywood/panelling wall, floor, cinder block supports,

etc.) should be compared to one another in order to establish ratios. The ratios will determine the number of subsamples to obtain from each individual component. For instance, if 20% of the area is cinder block, than 20% of the subsamples should consist of cinder block samples.

Generally, 20 to 30 subsamples are necessary to make-up one 110-gram composite sample for each building. This number will vary based on the number of components that make up the debris. For instance, if building demolition debris consists of 60% walls, 30% floor and 10% doors (based on surface area), 18 subsamples (60/100 x 30) could appropriately be from the walls, 9 from the floor and 3 from the doors.

e. Sampling Methodology:

(1) Using a 1-inch bit drill or similar device, "core" subsamples should be obtained from each component of the building demolition debris. The number of subsamples taken for each debris component relative to the other debris components will be based on the ratios calculated above. The subsamples should be collected into a disposable container (such as large sheets of paper) as the drilling is done. The sampling crew should -- to the extent possible -- drill through the entire thickness of each component (e.g., doors, floor, etc). For building debris components such as cinder block or cement, a hammer drill should be used. The number of drill holes obtained from each component should be recorded. If the amount of material collected for the total composite sample for the building is not enough (i.e., less than 110 grams) for the TCLP, additional subsamples should be obtained from each of the specific components, with the number of additional subsamples based on the above calculated ratios. [NOTE: For at least 5 percent of the samples (and a minimum of 1 sample) taken for each demolition project approximately 300 grams should be obtained for adequate split laboratory analyses.]

(2) Field duplicates, equaling 5 percent of the number of actual composite samples (at a minimum of one), taken after each demolition project, should be obtained to check the sampling practice. The duplicate(s) should be obtained by simultaneously filling two sample containers during the sample process (i.e., for each subsample within a sample building, two adjacent cores should be obtained and placed into two separate containers).

f. Collection and Labelling: The sample material from each building debris should be collected onto a (disposable) container (such as sheets of unused paper, paper plates, etc.). From this collection container, the materials should be emptied into clean (new) plastic baggies and labelled with the project/installation name and or identification number, sample (building) number, sample date, and sampling personnel's name.

g. Decontamination: Nondedicated sampling equipment such as the drill bit should be decontaminated between sampling of individual buildings. The sampling crew should first brush excess material from the equipment and then wash using tap water and soap. This should be followed by a final rinse with distilled, deionized, filtered (DDIF) water. To ensure the equipment was properly decontaminated, a used rinse water sample should be taken and analyzed.

LABORATORY ANALYSES:

a. Packaging and Transportation: All samples should be properly packaged before transporting them to the certified analytical laboratory.

b. Laboratory Preparation: To ensure thorough mixing of the composite sample, the laboratory should be requested to thoroughly mix/homogenize the sample before preparing it for analyses. This will minimize the "settling" that may occur during transportation. This procedure is extremely important when excess sample has been obtained and the laboratory will only be using a portion of the overall sample.

c. Analytical Methodology: All solid material being analyzed (wood/plaster/paintchip, etc.) should be extracted using EPA Method 1311 (TCLP). The samples should be analyzed using either EPA Method 6010A [Inductively Coupled Plasma (ICP)-Atomic Emission Spectroscopy] or EPA Method 7421, the Atomic Absorption, Furnace Technique for lead. The ICP procedure is recommended due to lower cost, but either method will satisfy EPA requirements. The rinsate sample should also be analyzed using one of these methods.

DATA ANALYSES:

a. The TCLP laboratory results should be statistically analyzed to assess the variability among the buildings of the demolition or rehabilitation project and overall normality of the TCLP lead concentration distribution. If the analytical results do not indicate a normal distribution (i.e., the arithmetic mean is not greater than the variance), the raw data should be transformed. After normality has been achieved through an appropriate transformation, the 80 percent confidence interval (CI) should be calculated and compared to the (similarly transformed) regulatory threshold (RT) of 5.0 mg/L for lead. (See SW-846--Test Methods for Evaluating Solid Wastes, Section 9.1.1.3, Basic Sampling Strategies).

b. Additional procedures may be necessary to address potential "statistical outliers," or buildings that yield unusually high TCLP lead concentrations that dramatically skew the 80 percent CI. If necessary, such buildings may be addressed as a separate population.

An example of a sampling/data analyses program is attached below (Example 1.0). See Test Methods for Evaluating Solid Waste, EPA Manual SW-846, Vol. II, Chapter 9, November 1986 (Attachment A) for detailed calculations.

EXAMPLE 1.0
STATISTICAL ANALYSES
Building Debris Samples: Collected May-June 1992

Bldg #	Pb Values (mg/L)	square root of Pb values	
4711	1.08	1.039	
4900	1.11	1.054	
4901	14.7	3.834	
4905	10.0	3.162	
4713	1.35	1.162	
3644	3.11	1.764	
3626	1.40	1.183	
3635	1.63	1.277	
3641	1.53	1.237	
3628	1.76	1.327	
3639	1.38	1.175	
3640	0.50	0.707	
3629	0.51	0.716	
3632	1.06	1.030	
3637	0.91	0.952	
3627	0.82	0.907	
4904	2.56	1.600	
3634	0.50	0.707	
mean	2.55	1.38	
std deviation	3.61	0.80	
std err	0.85	0.19	
normal	No	Yes	
80% CI*	N/A	1.63	*80% Confidence Interval = mean + ($t_{.20}$*std err); where $t_{.20}$=1.333 for df=17
trsfd RT	N/A	2.24	
Hazardous waste	N/A	No	

By performing a square root transformation of the values, the data shows a NORMAL distribution (the mean > the STD squared).

Since the 80% CI is LESS than the square root of the regulatory level of lead (5 mg/l) the waste is not hazardous.

Reference: Test Methods for Evaluating Solid Waste, EPA Manual SW-846, Vol. II, Chapter 9, November 1986. (Attachment A)

Method II. MASS BALANCE TCLP CALCULATION METHOD:

SCOPE:

a. This method is based on the assumption that for building demolition debris, only the paint will contain heavy metals (e.g., lead) while the unpainted building construction materials will contain no heavy metals. In this instance, TCLP sampling and analyses of only the paint is required. If the above assumption is not valid, then the Sampling/Statistical Analyses Method (Method I) must be used.

b. Before characterizing the waste, it is necessary to define the wastestream. The wastestream is the debris generated during a given demolition project at a given site/installation. While debris from all buildings/structures being demolished or rehabilitated constitute the wastestream, only a percentage of these buildings need be sampled. Details on how to determine the appropriate number of buildings to sample are presented in the "PROCEDURE" section below.

PROCEDURE: During a demolition debris waste characterization study, several site-specific determinations will need to be made. The following steps are detailed to the extent possible.

a. Defining Individual Wastestreams/Populations: As defined above, the wastestream consists of all the debris generated during a specified demolition project. A list of the buildings should be recorded, including the building components undergoing demolition, and notations of buildings that will be generating the same type of debris because they are the same or similar design and construction and are undergoing the same type of demolition or rehabilitation. Information should also be gathered regarding the demolition and disposal procedures.

For instance, if the structures are set on cement foundations it would be necessary to determine whether the cement is to be demolished and disposed of with the rest of the debris. If such foundations were to be left in place they would not be considered as debris; otherwise, they would be included in the wastestream and would be sampled in accordance with the procedures discussed below.

b. Determining the number of Samples: Based on EPA guidance (EPA/600/8-89/046, March 1989, Soil Sampling Quality Assurance User's Guide, 2nd Edition), a statistical approach will be used to determine the number of buildings that need to be sampled. This approach is based on the assumption that the buildings are all of a relatively uniform construction and that the analytical results of the study will be normally distributed.

The EPA manual SW-846--Test Methods for Evaluating Solid Wastes, Section 9.1.1.3, Basic Sampling Strategies (Attachment A), requires that the number of samples used to characterize a wastestream ensure an 80 percent confidence level in the resulting determination (in this case, hazardous or nonhazardous waste determination). Table 1 (Method I) is based on these guidelines and should be used to determine the number of buildings to be sampled.

c. Sample Buildings Selection: Once the number of buildings to be sampled has been determined, the specific buildings to be sampled need to be identified. For buildings generating identical or similar debris (made of the same construction materials and painted with the same paint) a random approach should be used in the selection process. Buildings may be randomly selected using building numbers or placement on maps. However, when one or more groups of buildings generating identical or similar debris constitutes a separate and distinct segment within the total number of buildings, an appropriate percentage of buildings should be selected from the individual group(s).

d. Sampling Strategy: The objective is to obtain one composite sample of paint from each building selected for sampling. Only samples of paint from the building components that will be part of the debris wastestream should be sampled.

e. Sampling Methodology:

(1) Using a scraper or similar device, paint samples should be obtained from each component of the demolition debris. Typically, one should sample each component of the debris that contains lead paint and combine the samples into one composite sample (knowing that at least a 100-110g composite sample is needed for a TCLP analyses and that at least a 10-15g sample must be obtained from each debris component). The choice of and number of samples should be approximately in proportion to the areas of each building component that has been painted with the lead paint and that will make up the debris wastestream. Table 2 below provides an example of the percentage of total building debris area that each debris component comprises and the number of grab samples that should be taken of each component. Again, if any of these building components will not be part of the debris wastestream, they should not be sampled. [NOTE: For at least 5 percent of the samples (and a minimum of 1 sample) taken for each demolition project approximately 300 grams should be obtained for adequate split laboratory analyses.]

TABLE 2- PERCENTAGES OF AREAS COVERED BY LEAD PAINT

Category	Area	Percentage	# of Subsamples
Interior			
Ceiling	519.6	13%	3
Walls	1137	28.4	6
Doors	352.4	8.9	2
Windows	132	5.8	1
Cabinets	46		1
Shelves	55		1
Exterior			
Siding, Attic	201.6	5.0	1
Siding, Walls	1000	25.0	5
Roof, Underside	200	5.0	1
Porch	355.5	8.9	2
Totals	3999.1	100.0%	23

(2) Field duplicates, equaling 5 percent of the number of actual composite samples (at a minimum of one), taken during each demolition project, should be obtained to check the sampling practice. The duplicate(s) should be obtained by simultaneously filling two sample containers during the sample process (i.e., for each sample within a sample building, an adjacent grab sample should be obtained and placed into a separate container).

f. Collection and Labelling: The sample material from each building debris should be collected onto a (disposable) container (such as sheets of unused paper, paper plates, etc.). From this collection container, the materials should be emptied into clean (new) plastic baggies and labelled with the project/installation name and or identification number, sample (building) number, sample date, and sampling personnel's name.

g. Decontamination: Nondedicated sampling equipment such as the drill bit should be decontaminated between sampling of individual buildings. The sampling crew should first brush excess material from the equipment and then wash using tap water and soap. This should be followed by a final rinse with distilled, deionized, filtered (DDIF) water. To ensure the equipment was properly decontaminated, a used rinse water sample should be taken and analyzed.

LABORATORY ANALYSES:

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c. Analytical Methodology: All paint being analyzed should be extracted using EPA Method 1311 (TCLP). The samples should be analyzed using either EPA Method 6010A [Inductively Coupled Plasma (ICP)-Atomic Emission Spectroscopy] or EPA Method 7421, the Atomic Absorption, Furnace Technique for lead. The ICP procedure is recommended due to lower cost, but either method will satisfy EPA requirements. The rinsate sample should also be analyzed using one of these methods.

DATA ANALYSES:

I) TCLP DATA ANALYSES:

a. If only one building was sampled (e.g., the same paint was used in the other buildings) no statistical analyses need be performed on the TCLP data. If more than one building was sampled the TCLP laboratory results should be statistically analyzed to assess the variability among the buildings of the demolition project and overall normality of the TCLP lead concentration distribution. If the analytical results do not indicate a normal distribution (i.e., the arithmetic mean is not greater than the variance), the raw data should be transformed. After normality has been achieved through an appropriate transformation, the 80 percent confidence interval (CI) should be calculated.

b. Additional procedures may be necessary to address potential "statistical outliers," or buildings that yield unusually high TCLP lead concentrations that dramatically skew the 80 percent CI. If necessary, such buildings may be addressed as a separate wastestream.

II) TOTAL WASTESTREAM TCLP DETERMINATION:

After obtaining statistically acceptable TCLP of the paint from step I, above (where only one building had to be sampled, the TCLP value for the one composite sample is used), the TCLP level of the total debris wastestream can then be estimated from a TCLP sample. The key relationship can be derived as follows:

$$TCLPwaste = TCLPpaint \times mp / mw,$$

Where mp is the mass of the paint on the building surfaces, and mw is the total mass of the debris wastestream generated. This simple proportion will provide a reasonable estimate of the TCLP for the debris wastestream which can be directly compared to the regulatory standard (e.g., 5.0 mg/l for lead).

a. Estimation of the Mass of Paint and Total Wastes:

Two basic formulas will be defined to estimate the parameters, mp and mw:

$$mp(kg) = Ap(ft^2) \times dp(ft) \times rp(g/cc) \times 28.3\ (kg/ft^3)$$

where Ap is the surface area of paint; dp is the depth of the paint surface; and rp is the paint density and 28.3 (kg/ft^3) is the density of water.

$$mw(kg) = Vi(ft^3) \times ri(g/cc) \times 28.3\ (kg/ft^3)$$

where i are the various debris components, such as wood, concrete, brick, etc, Vi is the volume and ri is the density of each debris component. The mass of each of the separate components are estimated using standard construction estimation techniques.

Estimation values for the densities of materials and the depth of the paint surface can be obtained from many sources. The density values given below are from "The Handbook of Chemistry and Physics" and the experience of the agency. Estimated average paint depth was obtained from the Denver Housing Authority.

Estimated values for ri, rp and dp:

Density of Concrete	2.5 g/cc
Density of Wood	.6 - .8 "
Density of Glass	2.5 "
Density of Steel	7.5 "
Density of Plaster	1.5 "
Density of Gypsum Board	.8 "
Density of Brick	2.0 "
Density of Stone (typical)	2.5 "
Density of Soil (dry)	1.4 "
Density of Pipe	7-8 "
Density of Paint	1.2 "
Average Paint depth	1/100 inch (8.33×10^{-4} ft)

The paint depth value is considered reasonably representative, but if the TCLP sample contains abraded material (such as wood or plaster), the average depth should be measured on-site and the mass of paint plus abraded material calculated.

The estimation of the volume of waste materials and the area covered by the paint surface will take the greatest amount of time. As an example of how this can be done, a typical one story house design was created for calculation purposes (Table 3). Where a number of similar buildings are involved, a single "representative" building could be used. If architectural drawings happen to be available, much of the information can be obtained directly from them.

Lead-painted surfaces are assumed to include all interior walls and ceilings as well as interior trim, windows, doors and kitchen cabinets. It is also assumed that the outside walls of the house and porch were painted with lead based paint.

Many of the volumes for the foundation, framing, and plaster surfaces can be estimated from geometric properties. Density values and the specific weight of water in kg/ft^3 are multiplied by the volume to obtain the weights for each material. The complexity due to the number of items involved is characteristic of residential housing. Federal installation buildings may be somewhat simpler.

Table 3 summarizes the calculation results for the basic structural categories. Area calculations are provided only where it is assumed that lead based paints were applied. The total estimated weight of the house and associated materials was 72,173 kg, which constitutes the debris wastestream. The total painted interior surface area was 2242 ft^2; the outer painted surfaces totalled 1757.1 ft^2. It was assumed that the paint thickness was .01" on average. The estimated weight of paint was 113.1 kg, the total mass of sample containing lead.

TABLE 3. HOUSE ESTIMATION VALUES BY CATEGORY

Category	Volume(ft^3)	Density Factors	Weight
Estimate of Total Debris Mass			
Concrete	648.5	x 2.5 x 28.3 =	45,881 kg
Brick Chimney	59.1	x 2.0 x 28.3 =	3,345
Wood, Framing	653.8	x .7 x 28.3 =	12,952
Asphalt Roofing	26.0	x 1.5 x 28.3 =	1,104
Steel, Glass, Appliances			1,466
Soil & debris	100	x 1.4 x 28.3 =	3,962
Plaster/Lath	86.3	x 1.5 x 28.3 =	3,663
Sum			72,372 kg

Estimate of Paint Areas and Mass:

Interior	Area (ft^2)
Ceiling	519.6
Walls	1137
Doors	352.4
Windows	132
Cabinets	46
Shelves	55
Totals	2242

paint weight (kg) = paint area(ft^2) x paint depth x paint density

= 1.868 ft^3 x 1.2 x 28.3 = 63.4 kg

Exterior	Area (ft^2)
Siding, Attic	201.6
Siding, Walls	1000
Roof, Underside	200
Porch	355.5
Totals	1757.1

= 1.464 x 1.2 x 28.3 = 49.7 kg

Sum of all building paint = interior + exterior paint mass =
63.4kg + 49.7kg = 113.1 kg

b. Calculations of the TCLP for the Waste:

The ratio of masses, mp/mw = 113.1/72373 = 1.56 X 10^{-3}. This means that for a value of 5 mg/l TCLP to be equalled or exceeded in the debris a corresponding TCLP value of: 5/1.56 x 10^{-3}, or 3200 mg/l Pb, would have to be obtained in the paint sample.

Figure 1
Example Diagram of a Building
(WWII Temporary Barracks Slated for Demolition)

Inside: Partition Walls
Ceiling
Floor

Inner Structure: "Studs"
Support Beams