



Standard Specification for Engineered Wood Fiber for Use as a Playground Safety Surface Under and Around Playground Equipment¹

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INTRODUCTION

The need for a systematic means of evaluating engineered wood fiber for use as a playground safety surface from the standpoint of particle size, consistency, purity, and ability to drain, has become a growing concern of the designers, operators, and manufacturers of engineered wood fiber systems. There has been no qualitative method to assess these parameters of engineered wood fiber (that is, particle size, consistency, purity, and ability to drain) to ensure its quality. Therefore, the goal of this specification is to establish a uniform means to measure the characteristics of engineered wood fiber in order to provide the potential buyer with performance specifications to select an engineered wood fiber suitable to meet the needs of playground designers, operators and manufacturers.

1. Scope

1.1 This specification establishes minimum characteristics for those factors that determine particle size, consistency, purity, and ability to drain.

1.2 Engineered wood fiber that meets the requirements of this specification must comply with Specification F1292, if the surface is in the use zone as defined in Specification F1487.

1.3 A sample of wood fiber that meets the requirements of this specification may be designated engineered wood fiber and be suitable for playground surfacing.

1.4 This specification does not imply that an injury cannot be incurred if the engineered wood fiber complies with this specification.

1.5 To meet the requirements of this specification, the material shall perform as follows:

1.5.1 The material shall meet particle size requirements.

1.5.2 The material shall meet the requirement for metal particles.

1.5.3 The material shall meet the allowable heavy metal concentrations considered hazardous to children.

1.5.4 The material shall meet the requirements of Specification F1292.

1.6 The values stated in inch-pound units are to be regarded as standard. The values in parentheses are mathematical conversions. SI units, which are provided for information, are not considered the standard, except in 8.4.

1.7 **Warning**—Mercury has been designated by EPA and many state agencies as a hazardous material that can cause central nervous system, kidney, and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury-containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's website (<http://www.epa.gov/mercury/faq.htm>) for additional information. Users should be aware that selling mercury or mercury-containing products, or both, in your state may be prohibited by state law.

1.8 The following precautionary statement pertains to the test method portions only, in 7.4, 8.4, and 9.4 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

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Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

- 2.1 ASTM Standards:²
 - C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - D1193 Specification for Reagent Water
 - D2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
 - E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
 - F963 Consumer Safety Specification for Toy Safety
 - F1292 Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment
 - F1487 Consumer Safety Performance Specification for Playground Equipment for Public Use
- 2.2 Other Standards and Methods:
 - Method 6010B Inductively Coupled Plasma-Atomic Emission Spectrometry (for the determination of heavy metal concentrations) as found in the Solid Waste Manual—SW846³
 - Method 7470A Mercury in Liquid Waste (manual cold-vapor technique) as found in the Solid Waste Manual—SW 846⁴
 - Handbook for Public Playground Safety U. S. Consumer Product Safety Commission Publication No. 325⁵
 - ISO 3696 Water for Analytical Laboratory Use—Specification and Test Methods⁶

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

- 3.1.1 *around playground equipment, n*—the area under and surrounding playground equipment established as protection from falls from equipment.
- 3.1.2 *engineered wood fiber, n*—processed wood that is ground to a fibrous consistency, randomly sized, approximately ten times longer than wide with a recommended maximum length of 2 in. (50.8 mm), free of hazardous substances, and meets the criteria of this specification.
- 3.1.3 *hand manipulation, n*—aligning the engineered wood fiber particles by hand so that the smallest dimensions confront

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard’s Document Summary page on the ASTM website.

³ Available from The American Public Health Association, 1015 Fifteenth St., NW, Washington, D.C. 20005.

⁴ SW 846 is found in the manual of “Standard Methods for the Examination of Water and Waste Water,” 18th Edition 1992, prepared and published by The American Public Health Association, 1015 Fifteenth St., NW, Washington, D.C. 20005.

⁵ Available from U.S. Consumer Product Safety Commission, 4330 East-West Highway, Bethesda, Maryland 20814-4408.

⁶ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

the face of the sieve screen and placing them through the screen without the use of force.

3.1.4 *loose fill system, n*—a surface system consisting of small independent, movable components; that is, engineered wood fiber, sand, gravel, wood chips, etc.

3.1.5 *normal use, n*—play modes that conform to the instruction accompanying the playground surface that have been established by tradition, custom, or that are evident from an examination of the playground.

3.2 Definitions: Definitions of Terms Specific to Playground Equipment:

3.2.1 *head injury criteria (HIC), n*—a measure of impact severity that considers the duration over which the most critical section of the deceleration pulse persists as well as the peak level of that deceleration.

3.2.2 *impact attenuation, n*—the ability of a surface system to reduce and dissipate the energy of an impacting body.

4. General Requirements

4.1 Playground surfaces represented as complying with this specification shall meet all applicable requirements specified herein. Anyone representing compliance with this specification shall keep such records as are necessary to document any claim that the requirements within this specification have been met.

4.2 For the surface within the fall zone of the surrounding playground equipment, the surface must meet U.S. Consumer Product Safety Commission guidelines minimum requirements at its critical height when tested in accordance with Specification F1292.

4.3 Certification compliance to this specification shall be conducted by an independent accredited testing laboratory.

4.4 Performance Requirements for Sieve Analysis:

4.4.1 When engineered wood fiber is tested in accordance with 7.4 of this specification, it shall meet the following criteria to be considered acceptable engineered wood fiber.

4.4.2 The minimum and maximum percent (%) by weight passing through the three sieves shall be as follows:

Sieve Size	Minimum %	Maximum %
¼ in. (19.0 mm)	99 %	100 %
⅜ in. (9.5 mm)	78 %	100 %
No. 16 (0.0469 in. (1.1 mm))	0 %	15 %

4.5 Performance Requirements for Hazardous Metals:

4.5.1 The maximum heavy metal concentration of soluble migrated elements after being corrected for statistical error is shown in 4.5.2.

4.5.2 The criteria in Table 1 must be met to be considered acceptable engineered wood fiber:

4.6 Performance Requirement for Tramp Metal:

TABLE 1 Maximum Soluble Migrated Element in ppm (mg/L) Engineered Wood Fiber^A

Antimony (Sb)	Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Chromium (Cr)	Lead (Pb)	Mercury (Hg)	Selenium (Se)
60	25	1000	75	60	90	60	500

^A Information in this table taken from Specification F963.

4.6.1 When wood fiber is tested in accordance with 9.4 and 9.5, the total number of metal particles with a dimension of $\frac{1}{2}$ in. (1.27 cm) or greater shall not exceed 0 per 50 yd³ (38.23 m³) pile sampled to be considered acceptable engineered wood fiber.

5. Summary of Methods

5.1 Samples of representative wood fiber are tested in accordance with: Test Method C136 and Specification F963, modified for this specification.

5.1.1 Test Method C136 provides a test method for determination of particle size distribution by passing a sample of dry engineered wood fiber of known mass through a series of sieves of progressively smaller openings.

5.1.2 Specification F963, hazardous soluble elements are extracted from engineered wood fiber under conditions that simulate the situation in which the engineered wood fiber stays 4 h in the alimentary tract after swallowing. The content of the soluble elements in the extract is determined for antimony (Sb), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), and selenium (Se).

5.1.2.1 Method 7470A Mercury in Liquid Waste (manual cold vapor technique) as found in the Solid Waste Manual SW846 is used to determine the levels of mercury in the engineered wood fiber.

5.1.2.2 Method 6010B Inductively Coupled Plasma-Atomic Emission Spectrometry (for the determination of heavy metal concentrations) as found in the Solid Waste Manual SW846 will determine the levels of hazardous heavy metals.

5.1.3 Two methods are used to determine the presence of tramp metal in engineered wood fiber playground surfacing; one is using a powerful rare earth magnet on the end of a probe specifically written for this specification; the other is a visual inspection.

6. Sampling

6.1 The following procedure will be used to collect the gross wood fiber sample. The sieve test sample and the hazardous substance (heavy metal) sample will be taken from the gross engineered wood fiber sample. The entire gross wood fiber sample will be tested for tramp metal.

6.1.1 The gross sample of engineered wood fiber shall represent a stockpile of 50 yd³ (38 m³) or greater.

6.1.2 Eight 1-gal (3.8-L) samples shall be taken. They shall be taken from four different quadrants of the stockpile 2 to 4 ft above the base and four different quadrants 4 to 6 ft above the base. Dig 1 to 2 ft into pile at each sample point. Combine and thoroughly mix the 8-gal (15.1-L) sample to achieve a homogeneous blend.

6.1.3 The thoroughly mixed 8-gal (15.1-L) sample will be known as the gross 8-gal (15.1-L) sample.

7. Sieve Test Analysis Method

7.1 Significance and Use:

7.1.1 *Sieve Analysis*—This test method is used to determine grading of engineered wood fiber-type material for proposed use as an engineered wood fiber playground safety surface. The results are used to determine compliance of the particle size

distribution with applicable specification requirements and to provide necessary data that will indicate sufficient porosity for drainage, and larger particle size to limit compaction and maintain resilience and limit oversize pieces that could cause injury.

7.2 Test Apparatus:

7.2.1 *Balances*—Balances or scales used in testing fine and coarse aggregate shall be readable and accurate to 0.5 g or 0.1 % of the test load, whichever is greater, at any point within the range of use.

7.2.2 *Sieves*—The sieve cloth shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. The sieve cloth and standard sieve frames shall conform to the requirements of Specification E11. Nonstandard sieve frames shall conform to the requirements of Specification E11 as applicable.

7.2.2.1 Sieve sizes required: $\frac{3}{4}$ in. (19.05 mm), $\frac{3}{8}$ in. (9.53 mm) and No. 16, 0.0469 in. (1.19 mm), mounted on standard frame 8 in. (203.20 mm) diameter 2 in. (50.8 mm) height.

7.2.3 *Sieve Shaker*—A mechanical sieving device, if used, shall create motion of the sieves to cause the particles to bounce, tumble, or otherwise turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion for adequacy of sieving described in this test procedure is met in a reasonable time period.

7.2.4 *Oven*—An oven of appropriate size capable of maintaining a uniform temperature $60 \pm 5^\circ\text{C}$ ($140 \pm 9^\circ\text{F}$).

7.3 Sample Test Preparation:

7.3.1 From the gross 8-gal (15.1-L) sample of engineered wood fiber, measure a 1-gal (3.8-L) sample for drying.

7.3.2 Dry the sieve test sample of wood fiber in accordance with the following method. (A constant moisture level is necessary to prevent weight changes due to changing moisture levels in the sample).

7.3.3 The wood fiber sample was reduced in overall size to facilitate testing using a standard 2-in.-deep 8-in.-diameter sieve. Because of the light weight of wood fiber, the oven dried sample weight of individual samples to be tested shall not generally exceed 0.40 lbs (181 g). Sieve screens, sieve frames, and wire cloth shall conform to the requirements of Specification E11. Samples shall be oven dried to a constant weight in general accordance with Practice D2217 for oven drying of samples following reduction of the mass (oven temperature of 140°F and accuracy to $\pm 9^\circ\text{F}$ ($60 \pm 5^\circ\text{C}$)).

7.4 Test Preparation for Sieve Analysis:

7.4.1 Because of the irregular shapes of the wood particles, hand manipulation of the sample through the sieve screens may be necessary.

7.4.2 Nest the three sieves ($\frac{3}{4}$ in. (19.05 mm), $\frac{3}{8}$ in. (9.53 mm), and No. 16, 0.0469 in. (1.19 mm)) in order of decreasing size of opening from top to bottom and place the sample on the top sieve.

7.4.3 Agitate the sieves by hand or by mechanical apparatus for a sufficient period, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving described in 7.4.5.3.

7.4.4 Limit the quantity of material on a given sieve so that all particles have the opportunity to reach sieve openings a number of times during the sieving operation.

7.4.5 Prevent an overload of material on an individual sieve by one of the following methods:

7.4.5.1 Insert an additional sieve with opening size intermediate between the sieve that may be overloaded and the sieve immediately above that sieve in the original set of sieves.

7.4.5.2 Split the sample into two or more portions, sieving each portion individually. Combine the masses of the general portions retained on a specific sieve before calculating the percentage of the sample on the sieve.

7.4.5.3 Continue sieving for a sufficient period and in such manner that, after completion, not more than 1 mass % of the residue on any individual sieve will pass that sieve during 1 min of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per min, turn the sieve about one sixth of a revolution at intervals of about 25 strokes. In determining sufficiency of sieving for sizes larger than the 0.19-in. (4.75-mm) (No. 4) sieve, limit the material on the sieve to a single layer of particles. If the size of the mounted testing sieves makes the described sieving motion impractical, use 8-in. (203-mm) diameter sieves to verify the sufficiency of sieving.

7.4.5.4 Hand sieve larger particles by determining the smallest sieve opening through which each particle will pass. Start the test on the smallest sieve to be used. Rotate the particles, if necessary, in order to determine whether they will pass through a particular opening; however, do not force particles to pass through an opening. Hand manipulation shall not include forcing of the particles; however, natural breakdown of particles which are semi-attached through this practice is not necessarily detrimental.

7.4.5.5 Determine the mass of each size increment on a scale or balance conforming to the requirements specified in 7.2.1 to the nearest 0.1 % of the total original dry sample mass. The total mass of the material after sieving should check closely with original mass of sample placed on the sieves. If the amounts differ by more than 0.3 %, based on the original dry sample mass, the results shall not be used for acceptance purposes.

7.5 Sieve Test Calculations:

7.5.1 Calculate percentages passing in various size fractions to the nearest 0.1 % on the basis of the total mass of the initial dry sample.

7.6 Sieve Test Report:

7.6.1 Total percentage of material passing each sieve.

7.6.1.1 The total percentage of material that did not pass the $\frac{3}{4}$ -in. (19.05-mm) sieve (top) after hand manipulation is subtracted from 100% and reported as amount passing $\frac{3}{4}$ -in. (19.05-mm) sieve.

7.6.1.2 The total percentage of material that did not pass the $\frac{3}{8}$ in. (9.53 mm) sieve (middle) is added to the percentage that did not pass $\frac{3}{4}$ -in. (19.05-mm) sieve in 7.6.1.1 and the sum is subtracted from 100%; report as percent passing $\frac{3}{8}$ -in. (9.53-mm) sieve.

7.6.1.3 The total percentage of material that did not pass the No. 16, 0.0469-in. (1.18-mm) sieve (bottom) is added to the total percent that did not pass the $\frac{3}{8}$ -in. (9.53-mm) and the $\frac{3}{4}$ -in. (19.05-mm) sieves. Subtract the total percentage from 100%; report as percent passing No. 16 sieve (bottom).

8. Hazardous Metal Test Method

8.1 Significance and Use:

8.1.1 *Heavy Metal Limits*—This test method uses the section of Specification F963 that deals specifically with toxic heavy metals. Since it is possible for children on a playground to handle and place engineered wood fiber particles in the mouth, it is necessary to measure for toxic levels of heavy metals because of possible use of recycled pallets, waste wood, and demolition wood as raw materials used in engineered wood fiber for playground surfacing. Limit for toxic levels of heavy metals are taken from Specification F963, paragraph 4.3.5.2 Table 1 and are adjusted with a statistical error correction factor taken from paragraph 8.3.4.3 of that specification.

8.2 Test Apparatus:

8.2.1 *Metal Sieve*, plain weave wire mesh stainless steel metal sieve with a nominal opening of 0.5 mm (.0197 in.) (No. 35 sieve) and the following specifications:

(a) Nominal wire diameter: 0.315 mm,

(b) Maximum size deviation for an individual opening: +0.090 mm,

(c) Tolerance for average opening: ± 0.018 mm, and

(d) 6 % or less of the openings to exceed the nominal plus: +0.054 mm.

8.2.2 *pH*, a means of measuring pH with a minimum accuracy of 0.2 pH units.

8.2.3 *Membrane Filter*, with a pore size of 0.45 μm .

8.2.4 *Reagents*, Use only reagents of recognized analytical grade during the analysis.

8.2.5 *Hydrochloric Acid Solution*, 0.07 mol/L.

8.2.6 *Hydrochloric Acid Solution*, approximately 2.0 mol/L (7.3 % m/m).

8.2.7 *Type 3 Water*, in accordance with ISO 3696.

8.2.8 *Centrifuge*, capable of achieving 5000 ± 500 rpm.

8.2.9 *Container*, of gross volume between 1.6 and 5.0 times that of the volume of HCL extractant.

8.3 Sample Preparation:

8.3.1 From the gross 8-gal (15.14-L) sample of engineered wood fiber, measure a 1-gal (3.79-L) sample and air dry sufficiently to eliminate particles sticking together due to moisture.

8.3.2 Using a No. 35 sieve, mechanically agitate sufficient air dried engineered wood fiber through the sieve to obtain 1.06×10^{-1} oz. (3.0 g) of screened engineered wood fiber particles.

8.3.3 If necessary, the dried wood fiber can be ground through the No. 35 sieve.

8.3.4 The screened wood fiber sample will be analyzed for toxic heavy metal content.

8.4 *Test Procedure for Hazardous Metal:*

8.4.1 Prepare a test portion in accordance with 8.3.

8.4.2 Mix the 1.06×10^{-1} oz (3.0 g) test sample with 50 times its mass of an aqueous solution of 0.07 mol/L hydrochloric acid at $37 \pm 2^\circ\text{C}$. In case of a test portion of less than 1.06×10^{-1} oz (3.0 g), mix the test portion with 150.0 mL of this solution at the given temperature. Shake for 1 min.

8.4.3 Check the acidity of the mixture. If the pH is greater than 1.5, add drop-wise while shaking, an aqueous solution of 2 mol/L (7.3 % m/m) hydrochloric acid until the pH is between 1.0 and 1.5. Protect the mixture from light. Shake the mixture efficiently for 1 h continuously, and then allow the mixture to stand for 1 h at $37 \pm 2^\circ\text{C}$.

NOTE 1—It has been shown that the extraction of soluble cadmium can reveal a two-fold to five-fold increase when extraction is conducted in the light rather than the dark.

8.4.4 Without delay, separate the solids from the mixture by filtration through a membrane filter with a pore size of 0.45 μm . If necessary, centrifuge at 5000 ± 500 RPM for no longer than 10 min. Analyze the solution using methods 7470A and 6010B to determine the presence of the elements identified in 5.1.2.

8.4.5 If it is not possible to analyze the sample within one working day, stabilize by the addition of hydrochloric acid so that the resulting solution is approximately 1 mol/L of HCl; then proceed with methods 7470A and 6010B.

8.4.6 The analytical results as determined in 8.4.4 or 8.4.5 shall be adjusted by subtracting the analytical correction factor in Table 2 using the following method. This is necessary to make statistical correction for interlaboratory error.

8.5 *Hazardous Metal Analysis Test Report:*

8.5.1 The analytical results obtained shall be adjusted in accordance with the test method in 8.4.6 prior to comparing them to the maximum permissible values in 4.5.2 to determine conformance to this specification.

8.6 *Performance Requirement for Heavy Metals*—See 4.5.2.

9. **Tramp Metal Test Method**

9.1 *Significance and Use:*

9.1.1 *Tramp Metal Limits*—This test method will determine the presence of tramp metal particles in engineered wood fiber. Metal particles embedded in engineered wood fiber can cause

injury if a child were to fall or come in contact. The limit for tramp metal was set to reduce the chance of injury.

9.2 *Test Apparatus for Tramp Metal:*

9.2.1 An industrial grade magnetic wand with a probe of 56 ± 4 in. (1422.4 ± 101.6 mm). At the end of the probe is a cylindrical 6 in. (152.4 mm) long by 1 in. (25.4 mm) diameter neodymium iron-boron rare earth magnet (40 MGO) drawing of magnetic test probe in Fig. A1.1.

9.3 *Tramp Metal Test Sample:*

9.3.1 The tramp metal test sample shall be the gross sample of engineered wood fiber collected in 6.1.1 (50 yd^3 (38.23 m^3) stockpile).

9.4 *Magnetic Tramp Metal Test Procedure:*

9.4.1 With the magnetic wand, probe into the pile (28) times at each quadrant (112 total probes).

9.4.1.1 Insert probe into pile 36 in. (914.4 mm) or greater to retrieve tramp metal particles.

9.4.1.2 Remove metal particles from probe after each insertion. Record size and location of metal particles removed from the magnetic probe on the data log in Appendix X1.

9.4.2 At each quadrant, at four different heights measured from the base of the stockpile, randomly probe into the stockpile as follows.

9.4.2.1 Randomly probe seven times into the stockpile at or below the 15-in. (380-mm) height level.

9.4.2.2 Randomly probe seven times into the stockpile between 15-in. (380-mm) and 30-in. (760-mm) height level.

9.4.2.3 Randomly probe seven times into the stockpile between 30-in. (760-mm) and 45-in. (1.1-m) height level.

9.4.2.4 Randomly probe seven times into the stockpile between 45-in. (1.1-m) and 60-in. (1.5-m) height level.

9.4.3 Count all magnetic particles retrieved that have any dimension of $\frac{1}{2}$ in. (12.7 mm) or greater.

9.5 *Nonmagnetic Tramp Metal Test Procedure:*

9.5.1 Visually inspect the gross sample of the engineered wood fiber for any metal particles. Record size and location of metal particles on the data log in Appendix X1.

NOTE 2—Pay particular attention to the base of the pile where metal particles will migrate.

9.5.2 Collect all metal particles.

9.6 *Tramp Metal Report*

9.6.1 Record the total number of all metal particles which have any dimension of $\frac{1}{2}$ in. (12.7 mm) or greater.

9.6.2 Record the following data from Annex A1:

9.6.2.1 Verification of the magnetic probe strength is within 10 % of its original strength rating in accordance with

Annex A1 original strength _____ date _____
Present Strength _____ date _____

9.6.2.2 The date of the last magnetic probe strength test is within twelve (12) months of the magnetic tramp metal test.

Last magnetic probe strength test date _____

Magnetic tramp metal test date _____

TABLE 2 Analytical Correction

NOTE 1—Example of Calculations Using Table 2:

Example 1—The analytical result for lead is 120 mg/kg; the correction factor from Table 2 is 30 % (0.30). Adjusted analytical results = $120 - (120 \times 0.30) = 120 - 36 = 84$ mg/kg. The result does not exceed the allowed value for lead in the table and therefore is acceptable.

Example 2—The analytical result for chromium is 90 mg/L; the correction factor from the table is 30 % (0.30). Adjusted analytical results = $90 - (90 \times 0.30) = 90 - 27 = 63$ mg/L. The result exceeds the allowed value for chromium in the table and therefore is not acceptable.

Element	Sb	As	Ba	Cd	Cr	Pb	Hg	Se
Analytical Correction	60	60	30	30	30	30	50	60

10. **Keywords**

10.1 hazardous metal; magnetic probe; sieve test; tramp metal