UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 23 2003

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Treatment Standards for Mercury-Containing Debris

FROM: Robert Springer, Director
Office of Solid Waste

TO: RCRA Senior Policy Advisors
State Waste Managers

This memorandum discusses issues pertaining to the treatment and disposal of mercury-containing debris subject to the RCRA land disposal restrictions debris requirements at 40 CFR 268.45. This memorandum:

- clarifies the types of hazardous mercury-containing wastes that are eligible for management under the debris treatment standards, including whether containerized mercury is excluded as debris;
- provides information on the improved capabilities of mercury "retorters" to accept and recover mercury from debris-like waste; and
- describes how to meet the performance standards for the hazardous debris treatment technologies.

The topics that are discussed in this memorandum have been raised to the Agency as areas for clarification or have arisen from advancements in research and technology developments. However, we are aware that the information that we are providing will not answer all of the questions that you may encounter as you consider the appropriateness of technologies for site-specific conditions.

Background

Treatment Standards for Non-Debris Hazardous Wastes. For D009 wastes (wastes that meet the toxicity characteristic for mercury) that are not classified as debris and are not wastewaters or mixed (radioactive and hazardous) wastes, the RCRA land disposal restrictions (LDRs) set four treatment standards (see 40 CFR 268.40). These wastes are in either the "low mercury subcategory" (i.e., containing less than 260 mg/kg total mercury), or the "high mercury-

inorganic subcategory" (i.e., containing more than 260 mg/kg total mercury). The treatment standard for low mercury wastes requires that leachate from treatment residuals, using the Toxicity Characteristic Leaching Procedure (TCLP), have a mercury concentration of less than 0.025 mg/L (or 0.20 mg/L for residues from retorting). Treatment by stabilization can be used to achieve this standard. The treatment standard for "high mercury inorganic category" wastes, which contain more than 260 mg/kg total mercury, is mercury recovery ("RMERC") in a thermal processing unit that volatilizes and subsequently condenses the mercury. These units are commonly referred to as "retorters," and the recovery process as "retorting." (40 CFR, 268.42, Table 1).

Treatment Standards for Hazardous Debris Wastes. The treatment requirements for hazardous debris, which were promulgated in 1992, are based on performance standards and specified technologies that reflect the technical challenges of treating debris-like objects and cleaning up remediation sites (see 40 CFR 268.45). These requirements allow use of specified technologies as an alternative to meeting the standards for non-debris hazardous wastes (40 CFR 268.45(a)) that are otherwise required; in this memo, we refer to these treatment standards as the alternative debris standards. The treatment technologies that generally apply to mercury-containing debris are microencapsulation and macroencapsulation[1]. These technology options do not distinguish between debris containing high and low levels of mercury. EPA's guidance on how to best achieve the performance requirements for these technology options is described below.

It is important to remember that if the alternative debris standards are not used as the basis of compliance for the land disposal restrictions, the mercury-containing hazardous debris are subject to the non-debris standards, which include retorting for high-mercury wastes. The non-debris standards will also apply if the alternative debris standards cannot be adequately met.

What are Debris/Hazardous Debris?

Definition of Debris. Debris is defined at 40 CFR 268.2 (g) as a "solid material exceeding a 60 mm particle size that is intended for disposal and that is: A manufactured object; or plant or animal matter; or natural geologic material." The next section describes the exceptions to this definition.

Definition of Hazardous Debris. Under 40 CFR 268.2(h), *hazardous debris* means debris that contains a listed hazardous waste or exhibits a characteristic of hazardous waste. Deliberately mixing prohibited waste with debris to change the treatment classification from

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[1]Although "source separation" is not identified as a specific technology under the debris treatment standards, for waste streams with readily identifiable mercury sources, it is a preferred method of removing liquid mercury from hazardous debris waste streams, or of removing the mercury characteristic from the hazardous debris. (See further discussion of this technology later in the memorandum.)

waste to hazardous debris is not allowed under the dilution prohibition in 40 CFR 268.3.

What Is Not Hazardous Debris?

Exclusions from the Debris Definition. The debris regulations specifically exclude certain materials from the definition of "debris." One exception under the 40 CFR 268.2(g) debris definition of great pertinence to mercury-containing wastes is for "intact containers of hazardous waste that are not ruptured and that retain at least 75% of their original volume." The preamble to the Debris Rule discusses this exclusion in detail (see 57 FR 37225, August 18, 1992: "Intact Containers Are Not Debris").

EPA has long interpreted certain manufactured objects that hold liquids, including mercury-containing pumps[2] and batteries, to be "containers." Under 40 CFR 260.10, containers are defined as "any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled." Under this definition, mercury-containing items such as thermometers, pumps, manometers, thermostats, jars of elemental mercury, batteries, dental amalgam collection devices, and ampules are containers. These items, therefore, do not fall under the debris definition and are subject to the non-debris mercury treatment standards.[3]

In situations where intact containers are mixed with true debris (i.e., materials classified as debris under the debris rule) and the mixture is RCRA hazardous, the intact containers would have to be removed and managed separately. EPA also recognizes that certain states have passed regulations that prohibit disposal and require mercury recovery from mercury-containing devices.

Size Limitations. The debris standards require that debris contain materials 60 mm or greater in size. Many mercury-containing devices, such as automotive switches, are substantially smaller than 60 mm and would not be eligible for treatment under the debris treatment standard because of their size. It is important to note, however, that many switches would not likely be eligible as debris because they are intact containers, as discussed above.

What Hazardous Debris is Exempt from RCRA Subtitle C?

We are aware that there is some confusion about the regulatory status of certain hazardous debris that is currently exempted from RCRA Subtitle C. At the federal level, there are two main exemptions from the RCRA hazardous waste regulations that pertain to hazardous

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[2] Note that the debris rule preamble describes circumstances where pumps can be debris (57 FR 37225 and 37229). Pumps containing enclosed mercury, however, function as containers and would not be eligible as debris if the criteria for the intact container exclusion are met.

[3] States may have designated certain mercury-containing items such as thermostats as "universal wastes" under state regulations. Such designations allow for streamlined collection requirements, but do not exempt such wastes from the hazardous waste treatment requirements.

debris-like mercury-containing wastes. The first is for mercury wastes from households, such as thermostats and thermometers, which are exempted from the RCRA hazardous waste regulations under the household waste exclusion (see 40 CFR 261.4(b)(1)). The second exemption is for hazardous wastes that are generated by conditionally exempt small quantity generators (CESQGs; see 40 CFR 261.5). CESQGs are defined as those generators that generate less than 100 kg of hazardous waste per calendar month or less than 1 kg of acutely hazardous waste per calendar month. CESQG requirements also limit the facility's waste accumulation to less than 1,000 kg of hazardous waste, 1 kg of acute hazardous waste, or 100 kg of any residue from the cleanup of a spill of acute hazardous waste at any time.[4] As an example, under federal regulations, a small dental office collecting mercury amalgam scrap that exhibits the hazardous characteristic for mercury would be a CESQG if it did not exceed the hazardous waste limits noted above. EPA strongly recommends that households and CESQGs make every effort to preserve the integrity of mercury-containing devices and that such devices are collected and recycled.

It is important to note that certain states have passed laws or regulations requiring that collected mercury-containing household wastes or mercury-containing CESQG wastes be subject to specific treatment and management standards, such as retorting. In addition, nearly half of the states have not adopted the less stringent CESQG requirements, and generators of mercury-containing hazardous waste in such states are subject to the small (or large) quantity generator requirements, or to other more stringent state requirements. Therefore, you should consult your state agency(s) to determine whether more stringent state requirements are applicable.

Treatment Technologies for Mercury-Containing Debris

Table 1 of 40 CFR 268.45 (the debris regulation), Alternative Treatment Standards for Hazardous Debris, contains technology descriptions, performance and/or design and operating standards for each technology, and restrictions on contaminants for specific technologies. Table 1 categorizes technologies into three technology groups--extraction (physical and chemical), destruction (biological and chemical), and immobilization (macroencapsulation, microencapsulation, and sealing).[5] In our experience, the treatment technologies listed in Table I

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[4] Note that most mercury wastes will not be "acutely hazardous," and the larger generation and accumulation amounts would apply for purposes of this exemption. See 40 CFR 261.30(b).

[5]Destruction technologies are not applicable to metal contaminants. We are not aware of chemical extraction technologies that could be applied to remove mercury from debris. Physical extraction technologies listed under the debris standard, including abrasion, grinding, spalling, or vibratory finishing, might be capable of removing mercury contamination from certain contaminated surfaces; we are not, however, aware of any examples where these technologies have been used for this purpose. We anticipate that physical extraction technologies would present potential cross-media contamination, especially volatilization of mercury into the

that are applicable to mercury-containing debris are microencapsulation and macroencapsulation. However, source separation and retorting can also be effective technologies for mercury-contaminated debris.

The following section describes each of these technologies and EPA's guidance on how to best achieve the performance standard for microencapsulation and macroencapsulation. This guidance reflects the technical challenges associated with treating mercury, which can be difficult to stabilize and has the potential to become volatile at ambient conditions.

Retorting. Mercury retorters are capable of accepting many mercury-containing materials, including mercury-containing debris, with certain limitations and exceptions. The websites of existing vendors list a variety of retortable materials that could be potentially associated with debris, including cleanup materials, building materials and many mercury-added products such as those referenced earlier in this memorandum. In addition, vendors can manage different forms of mercury salts and compounds. Since the hazardous debris rule was promulgated in 1992, vendors have increased their capability to handle larger objects in their retorters. Vendors typically manage drums of waste, but can, in some instances, handle even larger objects, such as roll-off containers of wastes. In general, we encourage you to contact the vendors to determine if there are any size, concentration, or contaminant restrictions that would require pre-treatment or special management considerations, or that would prevent the waste from undergoing retorting.

RCRA regulations for mercury retorting are found at 40 CFR 266.100(d), which conditionally exempts certain metal recovery units from regulation under RCRA Subtitle C. To retain this conditional exemption, retorters must comply with waste limitations regarding organic matter content and heating value. Specifically, under 40 CFR 266.100(d)(2), a retorter cannot accept wastes exceeding 500 ppm by weight of Appendix VIII organics, as fired, and cannot accept wastes exceeding a heating value of 5000 BTU/lb or more. Please see 40 CFR 266.100(d) for more details on these provisions. To ensure that air emissions from mercury retorters are controlled adequately, the Agency also specified, as part of the Best Demonstrated Available Technology (BDAT) determination under the RCRA land disposal restrictions regulations, that the retorting unit either: (a) be subject to the mercury National Emission Standards for Hazardous Air Pollutants (NESHAP); (b) be subject to a Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) standard for mercury imposed pursuant to a Prevention of Significant Deterioration (PSD) permit; or (c) that it be subject to a state permit that establishes emission limitations (within the meaning of section 302 of the Clean Air Act (CAA)) for mercury (see 40 CFR 268.42 Table 1 (RMERC), and http://www.epa.gov/air/caa/caa302.txt). This standard is enforceable under RCRA pursuant to the authority in section 3008(a). There are no Maximum Achievable Control Technology (MACT) standards for mercury retorters set under

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atmosphere, that could make the technology unacceptably risky to the environment. Permitting authorities should ensure that this potential for risk is minimized. In addition, the removed mercury, associated media, and extraction materials that fail the Toxicity Characteristic for mercury would be subject to the RCRA hazardous waste requirements for non-debris wastes.

the CAA at this time. See 55 FR 22569-22570 (the June 1, 1990 Land Disposal Restrictions Third Third Rule) for more details on the RCRA requirements for retorters. For more information on the CAA requirements cited here, see http://www.epa.gov/ttn/catc/rblc/htm/rbxplain.html and http://www.epa.gov/ttn/nsr/psd_abs.html.

Source Separation. For mercury-containing debris exhibiting the D009 characteristic for mercury, we use the term "source separation" to refer to the process of removing mercury-contaminated material from the bulk of the debris. For example, mercury-contaminated piping or broken gauges could be removed and managed under the non-debris treatment standards for hazardous wastes. Although source separation is not listed as a specific technology under the debris standards on Table 1, in many circumstances, it will be the preferred approach to remove mercury-containing devices or other items with readily identifiable mercury from the debris, and may even result in removing the mercury characteristic from the debris.[6] Moreover, as noted earlier, where intact containers containing hazardous waste are mixed with true debris, the intact containers (such as mercury-added products) must be removed and managed separately as non-debris hazardous waste.

Microencapsulation. This technology involves mixing wastes with reagents and stabilization materials to produce a more stable waste form. The Table 1 performance standard for microencapsulation is that "the leachability of the hazardous contaminants must be reduced." EPA recently published the results of treatment research conducted on non-debris mercury wastes and pure elemental mercury to assess whether the current retorting standard could be supplemented with an alternative disposal standard (Notice of Data Availability (NODA), 68 FR 4481, January 29, 2003). The results of this study are applicable to mercury-containing debris. In the study, treated wastes were subjected to a range of highly buffered pH liquids and were sampled to determine the amount of mercury in the subsequent leachate. We concluded that the waste forms that we examined were not sufficiently stable across the range of expected Subtitle C landfill conditions for the Agency to propose an alternative treatment standard for all hazardous non-debris mercury wastes. The Agency also concluded, however, that, on a site-specific basis, taking into consideration actual disposal conditions, mercury wastes could be potentially treated via microencapsulation and disposed of in a protective manner.

EPA's treatment research provides information on specific factors that may be considered when evaluating microencapsulation for treatment and disposal of mercury-containing hazardous debris. These factors assist you in determining whether or not the performance standard for

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[6]As is the case for all characteristic wastes, removing the characteristic will not necessarily result in achieving compliance with the land disposal restriction treatment standards for that waste. Please also note, under 40 CFR 268.45(c), hazardous debris contaminated with a listed waste that is treated by an immobilization technology specified in Table I must be managed in a subtitle C facility.

microencapsulation–"leachability of the hazardous contaminants must be reduced"–is being met.[7] For example, the results of the treatability studies discussed above demonstrate that each treatment technology exhibits its own pattern of mercury leaching from the treated waste forms across a range of plausible pH conditions. The research also found a significant increase in leachability of one treated waste form as leachate salinity was increased (only one treated waste form was tested with increasing salinity). When assessing the appropriateness of microencapsulation for mercury-containing debris, the primary factors to keep in mind include the chemical composition of the leachates to which the stabilized waste will be exposed, including pH and major anions, cations and organic compounds. It is also important to consider what additional measures, if any (e.g., macroencapsulation), will be put in place to prevent leachate from mobilizing the hazardous constituents. Please note, as well, that free liquids are prohibited from land disposal in microencapsulated debris (see discussion in the debris rule preamble at 57 FR 37235 and RCRA regulations at 40 CFR 264.314 and 265.314).

Macroencapsulation. This technology uses surface coatings or jackets to substantially reduce surface exposure to potential leaching media. The performance standard listed in Table 1 for this technology is that the "encapsulating material must completely encapsulate debris and be resistant to degradation by the debris and its contaminants and materials into which it may come into contact after placement (leachate, other waste microbes)." Methods for ensuring that the encapsulating material completely encapsulates the waste are specific to the technology used. For example, leak-tightness or pressure testing of High Density Polyethylene (HDPE) pipes or containers has been approved for testing of treated debris. Visual inspection may be appropriate for verifying that sprayed-on or applied coatings have complete integrity, without cracks, voids or protruding waste to ensure that the hazardous debris is completely encapsulated. The performance standard also requires that the encapsulating material be resistant to degradation by the debris itself and the case-specific disposal environment. Information on the durability of potential encapsulating materials when exposed to multiple organic compounds can be found on the internet from many vendors of HDPE/Low Density Polyethylene (LDPE) products. For example, LDPE has general resistance to chemicals, although it is slowly attacked by strong oxidizing agents, and some solvents will cause softening or swelling. HDPE generally has higher chemical resistance than LDPE, but it too can be affected by solvents. In general, if significant organics are present in the waste or in the disposal environment leachate, plastic encapsulating materials should not be used as the primary basis of meeting the debris treatment standard, or should be carefully researched. It may be necessary to conduct case-specific testing, if you cannot find information in the literature on materials that would pertain to specific disposal conditions.

Another measure of the ability of a macroencapsulation technology to substantially reduce surface exposure to potential leaching media is the structural integrity of the waste form produced

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[7] Note that HSWA 3004(m) requires EPA to "promulgate regulations specifying those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized."

by the technology. This factor is especially significant for mercury-bearing wastes, as mercury is volatile at disposal temperatures, and if present in liquid form, is directly mobile. Because of the mobility of mercury as a gas and liquid, macroencapsulation may be an inappropriate technology for hazardous debris containing readily removable liquid mercury.[8] An assessment of structural integrity will depend upon the specifics of the encapsulating technology and the case-specific disposal environment. Note that the disposal environment may include significant short-term stresses from management in the disposal cell, including driving of heavy equipment over disposed wastes. Disposed waste forms also will be subjected to burial stresses, which can result in compression and long-term creep; these stresses can be significant, especially if load-bearing will be accommodated at pressure points. Some vendors of macroencapsulation technologies can provide information, based on testing or modeling, of the ability of their technology to withstand burial pressures, drops onto soft or hard material (e.g., concrete), internal pressures caused by the wastes, puncture (such as to simulate forklift puncture), and vibration (to simulate transportation). In addition, some waste forms, such as those involving plastics, will lose strength after burial and exposure to the temperature, pressure and chemical conditions in the disposal cell. As discussed above, information on the durability of potential encapsulating materials when exposed to organic compounds and to temperature can be found on the internet from many vendors of HDPE/LDPE products.

Questions?

Any questions on management of mercury-containing debris should be directed to Laurie Solomon on my staff at (703) 308-8443.

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[8] Some states consider land disposal of macroencapsulated waste containing liquid mercury as prohibited disposal of containerized liquids.. You should consult with your state agency(s) to determine whether they take such a position.