**Department of Energy**
Washington, DC 20585
October 25, 1999

RCRA Information Center
U.S. Environmental Protection Agency
Headquarters (5305W)
401 M Street, S.W.
Washington, D.C. 20460

**Docket Number F-1999-MTSP-FFFFF**

Dear Sir or Madam:

*Re: 64 FR 28949, "Potential Revisions to the Land Disposal Restrictions Mercury Treatment Standards"*

On May 28, 1999, the Environmental Protection Agency (EPA) published an advance notice of proposed rulemaking (ANPRM) regarding potential revisions to the Resource Conservation and Recovery Act (RCRA) land disposal restriction (LDR) treatment standards for mercury-bearing hazardous wastes. This ANPRM marks the beginning of a comprehensive review of existing treatment regulations applicable to mercury-bearing wastes and of the Agency's effort to revise, as warranted, such regulations to improve treatment and land disposal methods. The ANPRM requests comments and data regarding three key issues concerning the current LDR treatment standards for mercury-bearing wastes: retorting, incineration, and source reduction options. In addition, the ANPRM discusses treatability studies initiated by DOE's Mixed Waste Focus Area (in conjunction with EPA).

The Department of Energy (DOE) supports EPA's effort to comprehensively review the existing RCRA waste treatment regulations applicable to mercury-bearing hazardous wastes, and appreciates the opportunity to provide comments in response to this ANPRM. In general, DOE believes that recovery (from wastes) of pure mercury suitable for reuse should continue to have higher priority than direct treatment of high-mercury wastes for disposal. Notwithstanding, the Department agrees with EPA's conclusion that in the current supply-demand situation, where the supply of recovered mercury exceeds industrial consumption, treatment for disposal may be more protective of the environment than mercury recovery for some mercury-bearing wastes. With this in mind, DOE generally supports an LDR treatment standard for high mercury waste which encourages recycling (both thermal and non-thermal). Furthermore, DOE urges EPA to expand the LDR treatment standard for high mercury wastes to also provide the option of applying non-recycling treatment technologies.

DOE believes providing an LDR treatment standard that allows both mercury removal/recovery and direct disposal options is particularly important for mercury-bearing radioactive mixed wastes, because reuse of mercury recovered from such wastes rarely occurs (even in more favorable market conditions than now exist) due to the presence in the recovered mercury of residual radioactive materials. For this reason, regardless of any future proposal EPA decides to make involving the LDR treatment standards applicable to non-radioactive hazardous wastes, DOE encourages EPA to consider creating waste subcategories in appropriate waste codes for mercury-bearing mixed wastes, irrespective of their mercury concentrations. The LDR treatment standard for such waste

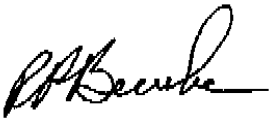
subcategories would consist of a concentration-based treatment standard that could be met by any acceptable treatment technology. In addition, options would be provided for particular mixed waste streams, or categories of mixed wastes, to meet specified technology treatment standards.

The enclosed comments describe several ongoing studies sponsored by DOE's Mixed Waste Focus Area (some in conjunction with EPA). These studies are intended to identify and develop a variety of mercury-bearing mixed waste treatment technologies capable of either mercury recovery/removal, or mercury stabilization/solidification. As the research is completed, DOE expects to offer additional data and information to EPA, beyond what is available at the present time. To that end, the enclosed comments have been formulated with input from DOE facilities that face mercury control challenges, and in coordination with DOE's Mixed Waste Focus Area.

The enclosed comments are divided into two sections: general and specific. The general comments provide overarching positions and requests. The specific comments relate directly to potential regulatory approaches and issues raised in particular sections of the ANPRM. For clarity, each specific comment is preceded by a reference to the section of the ANPRM to which it applies, and a brief description is given in boldface type of the issue within that section to which DOE's comment is directed.

As EPA's review of the need for revised LDR treatment standards for mercury-bearing hazardous wastes (including mixed wastes) continues, DOE looks forward to assisting the Agency in resolving issues of mutual concern. If you have any questions or need further clarification of our comments, please contact Bill Fortune of my staff at (202) 586-7302 or william.fortune@eh.doe.gov.

Sincerely,



Raymond P. Berube
Acting Director
Office of Environmental Policy and Assistance

Enclosure

cc: R. Chow, EPA, Office of Solid Waste (5302W)
J. Lewis, EPA, Office of Solid Waste (5302W)

# UNITED STATES DEPARTMENT OF ENERGY

# COMMENTS ON POTENTIAL REVISIONS TO THE LAND DISPOSAL RESTRICTIONS MERCURY TREATMENT STANDARDS

**ADVANCE NOTICE OF PROPOSED RULEMAKING**
**(64 FR 28949 - 28963; May 28, 1999)**

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**UNITED STATES DEPARTMENT OF ENERGY**
**COMMENTS ON POTENTIAL REVISIONS TO THE**
**LAND DISPOSAL RESTRICTIONS MERCURY TREATMENT STANDARDS**

**ADVANCE NOTICE OF PROPOSED RULEMAKING**
**(64 FR 28949 - 28963; May 28, 1999)**

## GENERAL COMMENTS

1. **The Department of Energy (DOE) supports the Environmental Protection Agency (EPA) efforts to reassess the existing treatment regulations applicable to mercury-bearing hazardous wastes, and to revise the regulations, as warranted, to improve treatment and disposal of these wastes. Further, DOE supports EPA's overall intent to reduce the generation of hazardous wastes containing mercury and, where that is not possible, to improve the recycling and treatment of residual mercury-bearing waste.**

DOE appreciates and supports EPA's effort to comprehensively review existing RCRA waste treatment regulations applicable to mercury-bearing wastes. The Department also agrees that as new data and information become available, and new or improved technologies are developed, it is appropriate and reasonable for EPA to reassess and, if necessary and appropriate, update the land disposal restrictions (LDR) treatment standards applicable to hazardous wastes. Because mercury is considered a persistent, bioaccumulative, and toxic chemical, it is particularly appropriate to review the LDR treatment standards for mercury-bearing wastes.

Mercury in elemental and various speciated forms is present in a number of DOE mixed waste streams. Many of these wastes are currently subject to the LDR treatment standard applicable to high mercury - inorganic hazardous wastes (i.e., roasting and retorting (RMERC)). Others are also subject to the high mercury - organic waste LDR treatment standard (i.e., incineration followed by appropriate residue treatment (IMERC); or RMERC). Still others must be incinerated due to the presence of polychlorinated biphenyls (PCBs), or they fall into the low mercury waste subcategory (less than 260 mg/kg total mercury) and must be treated to meet a concentration-based standard (0.025 mg/l TCLP). Some are radioactive elemental mercury and must be treated using amalgamation. Consequently, DOE is interested in each of the three key issues addressed in the advance notice of proposed rulemaking (ANPRM): incineration; retorting; and source reduction.

In general, DOE believes that recovery (from wastes) of pure mercury suitable for reuse should continue to have higher priority than direct treatment of high-mercury wastes for disposal. Notwithstanding, the Department agrees with EPA's conclusion that in the current supply-demand situation, where the supply of recovered mercury exceeds industrial consumption, treatment for disposal may be more protective of the environment than mercury recovery for some mercury-bearing wastes. With this in mind, DOE generally supports an LDR treatment standard for high mercury waste which encourages recycling (both thermal and non-thermal). However, DOE urges EPA to expand the LDR treatment standard for high mercury wastes to also provide the option of applying non-recycling treatment technologies.

DOE believes providing an LDR treatment standard that allows both mercury removal/recovery and direct disposal options is particularly important for mercury-bearing mixed wastes, because reuse of mercury recovered from such wastes rarely occurs (even in more favorable market conditions than now exist) due to the presence in the recovered mercury of residual radioactive materials. For this reason,

most mercury recovered from mercury-bearing mixed wastes must be treated according to the radioactive elemental mercury LDR standard and land disposed. However, in some circumstances involving remediation wastes, even where recovered mercury cannot be reused due to the presence of radioactivity, DOE believes that mercury recovery may still be superior to other treatments if it reduces the volume of mercury-bearing waste disposed. Hence, as DOE explains further in the specific comments on the ANPRM, the Department encourages EPA to consider creating new waste subcategories in appropriate waste codes for mercury-bearing mixed wastes, which would include not only high mercury mixed wastes, but also low mercury mixed wastes. The LDR treatment standard for such new waste subcategories would consist of a concentration-based treatment standard that could be met by any acceptable treatment technology. However, options would also be available for particular mixed waste streams, or categories of mixed wastes, to meet specified technology treatment standards, each of which could consist of one or more treatment steps.

As EPA acknowledges in the ANPRM, some mercury-bearing wastes are best treated using incineration (e.g., wastes having high organic content, or containing such constituents as PCBs). For such wastes, DOE supports retaining LDR treatment standards for mercury-bearing wastes that allow incineration. DOE believes the newly promulgated Maximum Achievable Control Technology (MACT) standards for hazardous waste combustors, in combination with site-specific risk-based RCRA permit conditions, should properly control mercury emissions from incinerators. To assure that DOE incinerators managing mercury-bearing mixed wastes comply with these standards and conditions, as applicable, DOE has implemented the following actions. First, as is explained further in the specific comments on the ANPRM, the Department is currently sponsoring feasibility studies on separating mercury from selected organic mixed wastes (*see* Specific Comment VI.G.1, item 2 (p. 17)). Second, DOE is participating in EPA/industry efforts to improve continuous emission monitoring for mercury emissions. Third, DOE is studying effective air pollution control device capture of mercury emissions from incineration of mercury-bearing wastes. Finally, DOE is studying effective means of removal of mercury from secondary wastes generated by incineration.

As EPA is aware, the DOE Office of Environmental Management (EM), Office of Science and Technology has formed the Mixed Waste Focus Area (MWFA) to develop, demonstrate, implement, and document technologies necessary for treating and disposing of mixed waste within the DOE complex. Since 1995, the MWFA has been working to develop solutions for challenges associated with the treatment of mixed waste streams contaminated with mercury, thus continuing and augmenting earlier DOE efforts in this area. The ANPRM acknowledges the contribution of the MWFA to EPA's efforts to identify and study new technologies for treating mercury-bearing mixed wastes in environmentally protective ways. DOE looks forward to continued collaboration between EPA and the MWFA as the Agency's review of the need for revised LDR treatment standards for mercury-bearing hazardous wastes (including mixed wastes) proceeds.

2. **DOE recommends that EPA establish an exemption from any new applicable LDR treatment standards that result from the rulemaking initiated by this ANPRM for mercury-bearing mixed wastes, which are treated before the effective date of the new standards, and which are being stored on that date awaiting disposal capacity.**

In the May 26, 1998, Phase IV LDR final rule, EPA adopted an exemption for certain treated D004 - D011 mixed radioactive wastes and treated mixed radioactive listed wastes containing metal constituents. Such wastes had been treated to meet applicable LDR treatment standards and then placed into storage before the effective date of the revised metal treatment standards promulgated in the Phase IV LDR final

rule. In establishing this exemption, EPA pointed out that radiation exposure to workers involved in conducting the retreatment would probably offset any gain in protection of human health and the environment resulting from compliance with the new Phase IV treatment standards (63 FR 28556, 28575-76 and 28642; codified at 40 CFR 268.40(h)). Based on the same logic, DOE recommends that EPA propose a similar exemption for mercury-bearing mixed wastes treated to meet standards applicable at the time of treatment, if such treated wastes remain in storage, awaiting disposal, on the effective date of new LDR treatment standards.

## SPECIFIC COMMENTS

### I. Introduction

### I.B. Key Issues Addressed in the ANPRM

1. **p. 28950, col. 3 --The preamble states that in some cases, direct treatment for disposal could have some environmental advantages over recovery of mercury via retorting in certain supply-demand situations that have not previously been fully appreciated.**

The ANPRM (see 64 FR 28951 - 28952) indicates that, since 1995, the supply of recovered mercury (i.e., mercury from secondary production) has exceeded the industrial consumption of mercury. DOE agrees that, in such a supply-demand circumstance, treatment for disposal may offer some clear environmental protection advantages over mercury recovery. However, as DOE commented in response to the Draft EPA Action Plan for Mercury,[1] the Department believes that recovery from wastes of pure mercury suitable for reuse should still be given higher priority than direct treatment of high-mercury wastes for disposal. Newer mercury recovery systems, particularly vacuum retort systems, have much lower mercury emissions than older roasting and retorting systems. Therefore, if recovery of mercury via such newer systems can avoid land disposal of significant quantities of mercury wastes and reduce the need for future mercury mining world wide (which has concomitant energy use and environmental effects), then it seems that mercury recovery would, in general, have greater environmental value than direct land disposal, even though storage of either mercury-bearing wastes or recovered mercury would be necessary until a use for recovered mercury arises.

2. **p. 28950, col. 3 – The ANPRM indicates that an issue EPA also intends to investigate is whether retorting (i.e., thermal recovery) is currently required for wastes that are either not amenable to or are inappropriate for (e.g., mixed wastes) this treatment.**

Notwithstanding DOE's belief stated in item 1, above, that recovery from wastes of pure mercury suitable for reuse should continue to have higher priority than direct treatment of high-mercury wastes for disposal, the Department submits that mercury recovery may not be the preferred approach in all cases. Specifically, the rationale that mercury should be recovered from hazardous waste because it can be reused does not generally apply to mercury-bearing mixed waste. Mixed wastes contain radionuclides

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[1] DOE letter from Office of Environmental Policy and Assistance to OPPT Document Control Officer dated February 12, 1999, in regard to notice of availability and solicitation of public comments on the draft Multimedia Strategy for Priority Persistent, Bioaccumulative and Toxic Pollutants and draft Action Plan for Mercury (63 FR 63926; November 17, 1998).

(e.g., cesium), and toxic metals other than mercury (e.g., lead), many of which may volatilize to some degree under roasting/retorting conditions. Thus, mercury recovered from roasting or retorting mixed waste is often contaminated with radionuclides and non-mercury toxic metals. As such, the recovered mercury is usually not suitable for reuse. Therefore, the recovered mercury is typically treated by amalgamation, which is the applicable LDR treatment standard for elemental mercury contaminated with radioactive material, and land disposed. Since mercury recovered from mixed waste can seldom be reused, DOE believes thermal recovery of mercury from high-mercury mixed waste is generally inappropriate. Therefore, DOE submits that the LDR treatment standard for high-mercury inorganic mixed waste, which requires treatment using RMERC, should be changed. In Specific Comment V.C.4, item 1 (p. 13), below, DOE poses an alternative regulatory approach.

## III. Mercury Hazardous Waste Generation and Management

### III.B. Generation of Mercury-Bearing Hazardous Wastes

1. **p. 28953, col. 3 -- In an effort to help construct a more accurate picture of the current mercury waste universe, EPA requests current data on waste generation (types, quantities, and mercury concentrations in the wastes), current waste management practices, problems and/or constraints on treating or recovering these wastes, as well as information on any waste minimization activities that may have been implemented to reduce or eliminate waste generation.**

Mercury in elemental and various speciated forms is present or expected in numerous existing and projected DOE mixed waste streams. The wastes involved take a variety of forms, which include soils; secondary waste liquids from former reprocessing of nuclear fuels; contaminated wiping rags and paper towels; used filters and filter sludge; protective clothing; hand tools; and equipment, debris, and spent decontamination liquids from decommissioning of research and development facilities and nuclear power plants. Table 5 in section VIII of the ANPRM summarizes inventory information on most existing mercury and mercury-contaminated mixed waste in the DOE Complex. Several additional DOE mercury-bearing mixed wastes that are not included in Table 5 are described below.

As of June 1999, DOE had an estimated 1.3 million gallons of high radioactivity, mercury-bearing, liquid mixed waste in storage at the INEEL that are not reported in Table 5 of the ANPRM. This waste is scheduled to be treated for disposal. The analyzed mercury content of the waste, which bears multiple waste codes, varies from 0.000474 to 0.0078 molar.[2, 3] A treatment technology has not yet been selected, but potential candidate treatments include thermal and stabilization methods, some of which involve mercury recovery followed by treatment of the recovered mercury for land disposal.

Also, projected volumes of mercury-contaminated materials likely to be generated from remediating existing mercury contamination at some DOE sites, and from decontaminating and decommissioning (D&D) of DOE buildings that contain mercury contamination are not reported in Table 5 of the ANPRM. Mercury-contaminated materials from such activities will include potentially large volumes of mercury-bearing media (i.e., soils, sediments, groundwater, and surface water) and debris. Thus far,

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[2] W. B. Palmer et al., "Status and Estimated Life of the 300,000-Gallon INTEC Tanks", Idaho National Engineering and Environmental Laboratory, INEEL/EXT-99-00743, July 1999.

[3] A molar solution contains one mole, or gram molecular weight, of the solute in one liter of solution.

DOE's experience indicates that generation of mercury-contaminated materials during remedial and D&D activities is, for the most part, not conducive to pollution prevention measures. Moreover, contaminated media and remediation debris generally contain other hazardous constituents in addition to mercury, notably radionuclides and PCBs. In one example of remedial wastes, DOE estimates that 900,000 kg of mercury were lost to the environment from the Oak Ridge complex during its operational history.[4] Oak Ridge is currently in the process of determining the best path for managing an estimated 61,000 kg of this mercury released in the vicinity of Building 9201-2 at the Oak Ridge Y-12 site. The quantities of radioactive mercury-bearing building debris and soil from a complete cleanup of the Building 9201-2 area alone are projected to exceed the current DOE mercury-bearing mixed waste inventory by orders of magnitude. In another example involving D&D wastes, the West Valley Demonstration Project (WVDP) noted in 1991 that mercuric nitrate was used by Nuclear Fuel Services in the chop-leach operation to suppress the volatility of iodine during fuel dissolution operations. It is estimated that the PUREX sludge (high-level waste) contains approximately 20 kg of mercury. As vitrification operations proceed at this site, some of the mercury will be stabilized in the vitrified high-level wastes. However, residual mercury is expected to be a hazardous constituent and/or an underlying hazardous constituent in an unknown quantity of hazardous debris and decontamination solutions generated by management of expended vitrification materials and eventual D&D of the facility.

Another quantity of DOE waste not reported in Table 5 of the ANPRM is the projected volume of secondary wastes, which will be generated by air pollution control systems (APCSs) on mixed waste incinerators. Emissions from DOE mixed waste incinerators are expected to comply by the prescribed date with the final National Emission Standards for Hazardous Air Pollutants (NESHAPs) applicable to hazardous waste incinerators (64 FR 52828, 52860; September 30, 1999), including the limits for mercury and dioxin/furan (D/F) emissions, and with any site-specific, risk-based limits established in RCRA permits. Facilities will comply by using feed controls with their existing or modified APCSs. Any facility that cannot comply is expected to shut down.

DOE anticipates that if carbon injection systems are added to its mixed waste incinerators to comply with the new mercury and D/F limits, the result will be considerable quantities of D/F- and mercury-bearing carbon wastes that are radioactively-contaminated. For example, as DOE explained in comments on the notice of data availability regarding revised technical standards for hazardous waste combustors, if a carbon injection rate of 5-20 lbs/hr is assumed for 7200 hours of operation during the course of a year, the estimated amount of additional radioactive waste generated falls between 36,000 and 144,000 lbs.[5]

Finally, Table 5 does not indicate the volumes of mercury-bearing mixed wastes that will be generated by the Spallation Neutron Source (SNS), which is planned for construction at the Oak Ridge National Laboratory in Tennessee. The SNS is a collaborative project involving five DOE national laboratories (Argonne, Brookhaven, Lawrence Berkeley, Los Alamos, and Oak Ridge). The project includes design and construction of what will be the most powerful spallation source in the world for neutron scattering R&D. The reference design calls for an accelerator system consisting of an ion source, a full-energy

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[4] "Mercury at Y-12, A Study of Mercury Use at the Y-12 Plant, Accountability and Impacts on Y-12 Workers and the Environment – 1950 to 1983," Mercury Task Force, Oak Ridge, Tennessee, Y/EX-24, 1983.

[5] DOE Comments in response to EPA's 5/2/97 proposed rule, "Revised Technical Standards for Hazardous Waste Combustion Facilities," (62 FR 24212), pp. 8-9, submitted to EPA on 6/17/97 (RCRA Docket #F-97-CS4A-FFFFF).

linear accelerator (linac), and an accumulator ring, which combine to produce short, powerful pulses of protons. These proton pulses impinge onto a mercury target to produce neutrons through the spallation nuclear reaction process. In addition to neutrons, the spallation process during the life of the facility will produce radioactive spallation products in the target, which will contaminate the mercury. Furthermore, the presence of the produced neutrons will activate the mercury itself in the target. As a result of the presence in the target of activated mercury and residual spallation products, operation and maintenance activities during the anticipated 40-year life of the SNS are expected to generate mercury-bearing mixed wastes consisting of approximately 18 $m^3$/yr of such materials as activated target modules, failed equipment, operational wastes (e.g., wipes, plastic bags, gloves), spent sulfur impregnated charcoal beds, filter cake, and ion exchange beds. Some of these materials will require remote handling due to the presence of high levels of radioactivity. At decommissioning, approximately 1 $m^3$ of elemental mercury, which will be activated and will contain radioactive spallation products, will also require disposition. The current SNS schedule estimates completion of the final design and receipt of construction authorization during 1999. Facility start-up is expected to occur around the end of 2006.

## V. Mercury Treatment Technologies - Roasting and Retorting of Mercury Wastes

### V.A. Process and Regulation

1. **<u>p. 28955, col. 3</u> -- EPA explains that the current LDR regulations: (1) mandate recovery via roasting and retorting of mercury waste that contains greater than or equal to 260 mg/kg total mercury; (2) impose regulatory control over the emissions from roasting and retorting and the disposal of residues derived from the process; and (3) differentiate between the residues from roasting and retorting versus other treatment processes to encourage recycling and recovery. EPA requests comment on whether the technology specified as the LDR treatment standard for high-mercury waste should be changed to include types of recycling technologies other than roasting or retorting.**

In general, DOE supports development of an LDR treatment standard for high mercury waste that includes other types of recycling technologies in addition to roasting or retorting. As was mentioned in Specific Comment I.B, item 2 (p. 3), above, mercury recovered by roasting and retorting mercury-bearing *mixed* waste has limited utility, and its reuse rarely occurs because the recovered mercury is often contaminated with radionuclides (e.g., cesium) and toxic metals other than mercury (e.g., lead). These contaminants are present in the original mixed waste and may be completely or partially volatilized, along with mercury, under roasting and retorting conditions.[6] Since reuse is rarely an option, mercury recovered from roasting or retorting mixed wastes usually must be amalgamated before land disposal to meet the existing LDR treatment standard for radioactive elemental mercury. With this situation in mind, DOE has concluded that the existing LDR treatment standard for high mercury hazardous wastes is not appropriate for all high-mercury mixed wastes. In response, DOE's Mixed Waste Focus Area (MWFA)[7]

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[6] Possible exceptions include mercury recovered by roasting or retorting mixed wastes contaminated only with low volatility radionuclides (e.g., uranium oxide) and toxic metals (e.g., chromium compounds).

[7] The Federal Facility Compliance Act of 1992 (FFCAct) (Pub. L. 102-386) required the Secretary of Energy to submit Site Treatment Plans for the development of treatment capacity and technologies for treating mixed waste for most of the DOE facilities which store or generate these wastes. The Site Treatment Plans commit DOE to characterize, treat, transport, and dispose of mixed wastes within certain time frames. To meet this commitment, the DOE Office of Environmental Management (EM), Office of Science and

and the DOE Federal Energy Technology Center (FETC) have supported development of alternative mercury extraction technologies to provide more options for treatment of some of the problematic mercury-bearing waste streams in the DOE complex. Information is provided below about new technologies being investigated to address RMERC issues, as well as IMERC issues, associated with specific waste types and matrices. Some of these technologies may also be better suited than roasting and retorting to certain non-radioactive high-mercury wastes.

**Medium-Temperature Thermal Desorption Process.** In 1997, the DOE Morgantown Energy Technology Center contracted with Mercury Recovery Services, Inc. (MRS) of New Brighton, Pennsylvania to conduct a pilot demonstration of the commercially available medium-temperature thermal desorption process to treat mercury-bearing mixed waste.[8] The objectives of the demonstration were: to recover mercury from low-level mixed waste containing metallic mercury and mercury compounds (i.e., HgO, HgS, $HgCl_2$); to effectively separate mercury from the radioactive component that remains in the residual matrix; and to determine the optimum process conditions that consistently produce treated residue, which contains total mercury at a concentration less than 1 mg/kg and which yields leachate, when subjected to the Toxicity Characteristic Leaching Procedure (TCLP), containing mercury at a concentration less than 0.2 mg/l (i.e., the TCLP leachate mercury concentration above which wastes are considered characteristically hazardous according to 40 CFR 261.24).

The MRS process consists of first crushing or shredding the contaminated material in order to achieve a preferred agglomerate size and desired surface area-to-volume ratio. The comminuted material is then combined with additives to decompose mercury compounds and eliminate gaseous sulfur and chlorine compounds from the process effluent. The blended material is next heated in a low-volume, low-velocity air stream in two stages. The first stage is a low-temperature stage during which water vapor and volatiles are vaporized without vaporizing significant quantities of mercury. The second stage involves increasing the temperature to 1000 to 1200 degrees F (540 to 650 degrees C) to vaporize mercury from the dry material. Water vapor generated during the first heating stage is exhausted to the atmosphere in gaseous form after passage through a series of columns charged with sulfur-impregnated carbon, which remove mercury and other impurities. Mercury vaporized during the second heating stage is condensed in a tube-in-shell heat exchanger to produce metallic mercury suitable for refining and recycling. Heat exchanger off-gas is then purified using sulfur-impregnated carbon prior to being exhausted to the atmosphere. All testing performed during the pilot demonstration was performed under Nuclear Quality Assurance (NQA-1) protocols.

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Technology formed the Mixed Waste Focus Area (MWFA) to document, develop, and implement the necessary technologies. The MWFA is managed by DOE's Idaho Operations Office and supported by Lockheed Martin Idaho Technologies Company. The MWFA established a Mercury Working Group in May 1996. The Working Group's objectives were to refine the technical baseline for DOE's mercury treatment needs, to identify potential new technologies for meeting those needs, and to facilitate development of the most promising technologies. The Working Group included representatives from the Oak Ridge Reservation [which encompasses East Tennessee Technology Park (formerly the K-25 Site), Oak Ridge National Laboratory, and the Y-12 Plant], the Savannah River Site, and Idaho National Engineering and Environmental Laboratory.

[8] See MRS process description: *Soil & Groundwater Cleanup Online*, Group III Communications (http://www.sgcleanup.com/waste/mercury2.html).

The pilot demonstration was completed in four tasks.[9] Task 1 involved identifying and selecting a matrix material that was representative of a typical DOE low-level mixed waste stream and preparing surrogate waste streams therefrom by characterizing the uncontaminated soil matrix and blending it into mixtures consisting of one or more of cerium, cerium oxide, mercury oxide, mercury chloride, mercury sulfide, metallic mercury, and naturally occurring radioactive material (NORM). The NORM was added in an amount below 20 pCi/g and was representative of non-volatile radionuclides. During Task 2, all of the samples were subjected to chemical and physical analyses, particle size determination, scanning electron microscopy, x-ray diffraction, and TCLP tests, in order to determine the physical and chemical nature of the matrix and its interaction with the contained additives. Task 3 determined the optimum processing conditions (time, temperature, carrier gas flow, physical and chemical pretreatments, etc.), determined the resulting residual mercury content and TCLP values for each, and confirmed the chosen conditions on the NORM samples while monitoring all feeds, treated materials, recovered mercury, and the exhaust gases for radioactivity in the NORM tests. Task 4 involved preparation of a preliminary design for a commercial processing facility capable of treating DOE wastes and a detailed projection of the capital and operating costs for commercial mobile and fixed site facilities having treatment capacities suitable for DOE remediation projects.

During the pilot demonstration, mercury levels up to 3,000 ppm in the waste stream were reduced to less than 1 ppm without disturbing the radioactive components in the waste stream, and with minimal secondary waste production. Hence, DOE believes this technology offers a viable means of removing and recovering the mercury from low-level mixed wastes that do not contain volatilizable radionuclides, obtaining an effective separation of the mercury from the radioisotopes by the retention of the NORM radioisotopes in the solid residuals, and economically processing low-level mixed wastes of volumes generated at DOE facilities. The technology is ready for scale up to commercial treatment of mercury-contaminated mixed wastes. The capital investment required to construct a facility capable of processing 110 tons of waste per day was estimated to be approximately $10.5 million. Operating costs for the same facility were estimated at $107 per ton of waste processed.

**General Electric Mercury Extraction Process (GEMEP℠).**[10] GEMEP℠ is a technology invented by General Electric Company that has undergone considerable testing by Metcalf & Eddy. The GEMEP℠ combines the oxidant iodine ($I_2$) with the complex-forming agent iodide ($I^-$) in a leaching solution that is able to extract a variety of mercury containing species from soils, sediments, glass wastes, and other materials. This is a three-staged, closed-loop process that contains and recycles the extraction components. The process treats mercury-contaminated media and produces mercury-free media, elemental mercury, and a metal precipitate consisting primarily of iron hydroxides. The three stages of the process are described below.

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[9] See pilot demonstration information: "Removal and Recovery of Mercury from Mixed Wastes," Technology Development Data Sheet, OST Reference Number 0267, Federal Energy Technology Center, May 1999. [On the Internet: go to http://www.fetc.doe.gov; select the link to "Site Index"; select the link to "Project Fact Sheets"; select the link to "Environmental Waste Management Project Fact Sheets"; select the link to "Mixed Waste Focus Area"; under "Completed Projects" select the link to item #7, "Mercury Recovery Services."]

[10] See GEMEP℠ technology description: "Mercury Removal," Technology Development Data Sheet, OST Reference Number 1708, Federal Energy Technology Center, May 1999. [On the Internet: go to http://www.fetc.doe.gov; select the link to "Site Index"; select the link to "Project Fact Sheets"; select the link to "Environmental Waste Management Project Fact Sheets"; select the link to "Mixed Waste Focus Area"; under "Active Projects" select the link to item #7, "Metcalf & Eddy, Inc."]

In the mercury extraction stage of the GEMEP℠, mercury-contaminated media is subjected to an aqueous extraction with potassium iodide and iodine ($KI/I_2$) under controlled pH and temperature. Mercury in its various forms is oxidized by the $I_2$ to the 2+ oxidation state, which is then believed to form soluble complexes of the form $HgI_4^{2-}$ by complexation with the $I^-$ present in the extraction medium. After sufficient reaction time to solubilize the mercury, the treated media is dewatered, rinsed to remove residual extraction reagent and dissolved mercury, and backfilled or disposed. The extracted mercury remains in the aqueous phase and serves as the feed stream for the mercury reduction and removal stage, along with the water generated from rinsing the treated media.

In the mercury reduction and removal stage of the GEMEP℠, the aqueous stream from the extraction step is reacted with finely divided elemental iron to reduce the mercury to its elemental form. The metallic mercury produced in this stage is recovered. The remaining aqueous phase, containing dissolved ferrous iron and extraction reagent, is treated by pH adjustment to precipitate the iron as ferric hydroxide. After dewatering, the precipitate can be combined with the treated solids from the extraction step for disposal, or it can be managed separately. The aqueous phase remaining after precipitation and dewatering is the feed stream for the reagent regeneration and recycle stage.

In the reagent regeneration and recycle stage of the GEMEP℠, the spent extraction reagent is regenerated through a combination of pH adjustment and chemical oxidation. The regenerated extraction reagent is recycled to the mercury extraction stage. The solution of aqueous potassium iodide plus iodine used as the leaching agent in the GEMEP℠ has been shown in bench-scale tests to be effective in removing mercury from surrogate soils as well as other wastes. A variety of forms of mercury, including elemental mercury, mercuric oxide, mercuric sulfide, and organomercury compounds, were removed from a wide range of materials such as soils, sediments, sludges, plastics, glass, concrete and brick. Work at Oak Ridge National Laboratory has demonstrated efficiencies of 97% to 99% for removal of mercury and its compounds from sediments and glass. Because the leaching agent is neither acidic nor basic, indigenous metals such as iron are not removed from the solids by the process.

The GEMEP℠ has removed mercury from actual waste to meet a 0.2 mg/l (TCLP) limit. However, the process may be susceptible to matrix interference when substances other than mercury react with the iodine.

**Polymer Filtration Technology.**[11] The Polymer Filtration Technology developed at Los Alamos National Laboratory is an aqueous-based mercury dissolution/polymeric adsorption decontamination system for extracting mercury from a variety of matrices and surfaces. This technology combines the most positive aspects of chelation technology with the convenience of ion-exchange technology. Chelating polymers are applied to contaminated surfaces along with surfactant or other dissolution-enhancing chemicals as aqueous solutions or foams. The metal-laden polymer is then rinsed into an ultra-filtration chamber where the polymer is captured. The other chemicals in the solution are recycled and the mercury-laden polymer is regenerated with the mercury eluted in a concentrated solution. Tests on surrogate wastes have indicated that the Polymer Filtration Technology is capable of reducing the mercury content to below 0.2 mg/l (TCLP). Testing will continue through 2000 to evaluate whether further mercury reductions are possible. DOE expects to offer these test results to EPA when they are available for release.

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[11] See description of Polymer Filtration Technology at http://www-emtd.lanl.gov/TD/Decon/PolymerFiltMercury.html

## V.B. Air Emissions from Roasting and Retorting

1. **<u>p. 28956, col. 3</u> – EPA requests additional data on air emissions from roasting and retorting units, including information detailing the effectiveness of existing after burner, carbon bed, and scrubber controls.**

Raduce/SepraDyne plans to perform a treatability study of mercury contaminated soils at Brookhaven National Laboratory in a vacuum retort pilot process. The collection of air emissions information is a planned part of that study. DOE expects to provide a copy of the final report to EPA when it becomes available (expected in 2000).

## V.C. Request for Comment

### V.C.1. What Wastes Are Not Amenable to RMERC?

1. **<u>p. 28956, col. 3 - p. 28957, col.1</u> -- In describing various wastes that are "problem wastes" for mercury recycling, the preamble states that only one mercury recovery facility has been identified that accepts radioactive mercury-bearing wastes. Most other facilities reject radioactive wastes for regulatory and safety reasons. EPA requests further information detailing the problems that occur when treating wastes in retorting units, including the forms of mercury wastes that are not technically amenable to retorting and/or are not accepted at retorting facilities.**

As mentioned in Specific Comment V.A, item 1 (p. 6), many radionuclides contained in mixed wastes (e.g., cesium) completely or partially volatilize under roasting/retorting conditions. A significant portion of DOE inorganic mercury-bearing mixed waste is also contaminated with non-radioactive lead and other contaminants that are relatively easily volatilized. Hence, mercury recovered from such mixed wastes by roasting or retorting is frequently contaminated with radionuclides and possibly other toxic metals. As such, mercury recovered from mercury-bearing mixed wastes by roasting or retorting is not typically suitable for reuse and must be land disposed. Consequently, if the recovered mercury is radioactive, it must be treated before land disposal according to the LDR treatment standard applicable to elemental mercury contaminated with radioactive materials (i.e., amalgamation) [40 CFR 268.40, Waste Code D009]. Therefore, the rationale for requiring mercury recovery from high-mercury wastes does not generally hold for mixed wastes. Thus, DOE contends that an LDR treatment standard mandating roasting or retorting of high-mercury mixed wastes is not appropriate. In that sense, DOE believes that most high-mercury mixed wastes are "not amenable" to retorting.

In 1998, EPA agreed with the conclusion that high mercury mixed wastes are not amenable to retorting when DOE requested a determination of equivalent treatment for soil treatability samples. The samples consisted of mercury-contaminated waste soils excavated in 1997 from a former land disposal area ("Chemical Holes Area") for miscellaneous laboratory wastes at Brookhaven National Laboratory located in Long Island, New York. Without the determination of equivalent treatment, the applicable LDR specified technology treatment standard for the samples (D009) would have been RMERC (retorting or roasting with recovery of the mercury for reuse) (40 CFR 268.40). Based on the information provided by DOE, EPA agreed with DOE that retorting or roasting of such soils would have been inappropriate because any mercury recovered would still have been contaminated with radioactive materials, which would have prohibited its unrestricted recycle or reuse as elemental mercury. Accordingly, the elemental mercury would have required land disposal after treatment using amalgamation, which is the specified

technology LDR treatment standard applicable to radioactive elemental mercury (40 CFR 268.40). Under such circumstances, EPA found that the recovery step would serve no useful purpose and would involve additional handling with the attendant concerns about potential exposure to radionuclides. Thus, EPA approved concentration level treatment standards equivalent to those applicable to residues of RMERC (i.e., 0.20 mg/l TCLP), but without the non-useful RMERC step.[12] The following table describes the waste soils to which the EPA-approved equivalent treatment standard applies.

**Initial Waste Descriptions**

| Waste Container ID[a] | Approx. Volume[a] ($yd^3$) | Approx. Weight[a] (kg) | Total Hg Concentra-tion[b] (mg/kg) | TCLP Hg Concentra-tion[a] (mg/l) | Primary Hg Species[a] | Other RCRA Constitu-ents that exceed TC Levels or are Listed Wastes[a] | Waste Descrip-tion & Treatment / Regulatory Subcate-gory[a] | Assigned EPA Waste Code[a] | Applicable LDR Treatment Standard[a] |
|---|---|---|---|---|---|---|---|---|---|
| Bin 1 | 2 | 2495 | 4028 | 3.56 | Elemental[c] | None Identified | Nonwaste-water, High Mercury Subcate-gory[d] | D009 | RMERC |
| Bin 2 | 2 | 2495 | 4420 | 0.263 | Elemental[c] | None Identified | Nonwaste-water, High Mercury Subcate-gory[d] | D009 | RMERC |

a. Source: Letter from EPA (E. Cotsworth, Office of Solid Waste) to DOE (G. Malosh, Brookhaven National Laboratory) regarding request for a determination of equivalent treatment, July 27, 1998.
b. Source: Mixed Waste Focus Area, 1999 (Total Mercury Concentrations (mg/kg) provided in this table have been updated (based on additional sampling) from those provided in the EPA Determination of Equivalent Treatment issued on July 27, 1998).
c. Determined by visual inspection.
d. Nonwastewaters that exhibit, or are expected to exhibit, the characteristic of toxicity for mercury based on the extraction procedure (EP) in SW 846 Method 1310; and contain greater than or equal to 260 mg/kg total mercury that are inorganic, including residues from RMERC.

Notwithstanding its contention that certain high mercury mixed wastes (such as the contaminated soil samples at Brookhaven National Laboratory) need alternative LDR treatment standards, DOE believes that for some contaminated media and remediation debris containing both mercury and radionuclides, retorting to remove mercury may be preferable to direct stabilization of the entire contaminated material stream. DOE is currently using the Brookhaven soil samples to study, among other things, the tradeoffs for direct stabilization of high mercury radioactive soils versus retorting. The results of these treatability studies are expected in 2000. Additionally, RMERC may still make sense for treatment of certain inorganic high mercury DOE mixed wastes that do not have volatilizable contaminants other than mercury.

DOE wishes to encourage EPA to increase the number of options available for treating mercury-bearing mixed wastes under the LDR regulatory program. In Specific Comment V.C.4, item 1 (p. 13), below, DOE suggests an approach for accomplishing this.

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[12] Letter from EPA (E. Cotsworth, Office of Solid Waste) to DOE (G. Malosh, Brookhaven National Laboratory) regarding request for a determination of equivalent treatment, July 27, 1998.

Regarding mercury wastes that are not accepted at retorting facilities, DOE remains concerned about potentially large volumes of radioactive carbon injection (or carbon bed adsorber) wastes, which could be generated as a result of complying with the final MACT standard for mercury and dioxin/furan (D/F) emissions (see Specific Comment III.B, item 1( p. 4), above). As DOE indicated in response to the notice of data availability regarding revised technical standards for hazardous waste combustors (62 FR 24212; May 2, 1997):[13]

> Should high mercury carbon [generated as a result of carbon injection or carbon bed adsorption technologies installed to control mercury emissions from mixed waste incinerators] also possess a radioactive component, it is DOE's understanding that current RMERC technologies are not capable of handling high mercury-inorganic (incinerator) carbon wastes that also possess a radioactive component. Accordingly, wastes within this treatability subgroup may require interim storage until a demonstrated technology becomes available.

DOE is not aware that RMERC technologies capable of handling high mercury-inorganic carbon wastes that also possess a radioactive component have become available since 1997, although current advances in vacuum retorting may change this picture.

### V.C.2. Should Non-Thermal Recycling Technologies Be Allowed for High Mercury Wastes and, if so, Should They Continue To Be Subject to a More Stringent Residual Standard?

1. **p. 28957, col. 1 – EPA indicates that if non-RMERC recycling processes are determined to be viable and are demonstrated to be properly designed and operated, the residuals could be subject to the current RMERC residual LDR treatment standard of 0.20 mg/l, or to a new treatment standard that the non-RMERC technology has been demonstrated to achieve. Alternatively, EPA suggests that recycling technologies other than RMERC could be added to the LDR treatment standard as options for treating high-mercury subcategory wastes.**

DOE would support expanding the current LDR treatment standards to include non-RMERC recycling technologies as options for treating high-mercury subcategory wastes, if such technologies are shown to be protective of human health and the environment. DOE opposes more stringent standards on residuals from non-RMERC recycling processes than from RMERC processes if such standards are intended solely to encourage RMERC. Total risk to human health and the environment created by the aggregated recycling process should be the deciding factor in establishing a TCLP concentration level to serve as the residue treatment standard for either an RMERC or a non-RMERC recycling process. Only if EPA determines that a more stringent TCLP concentration level standard is necessary for residuals from non-RMERC recycling processes than for residuals from RMERC in order to be protective, should EPA continue to impose more stringent standards for residuals from non-RMERC processes. In the absence of such a determination, DOE sees no justification for retaining a more stringent residue treatment standard for non-RMERC recycling processes than for RMERC.

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[13] DOE Comments in response to EPA's 5/2/97 proposed rule, "Revised Technical Standards for Hazardous Waste Combustion Facilities" (62 FR 42212), pp. 8-9, submitted to EPA on 6/17/97 (RCRA Docket # F-97-CS4A-FFFFF).

### V.C.3. Should the Mercury Concentration Requirement for RMERC (260 mg/kg or above) Be Adjusted?

1. **<u>p. 28957, col. 2</u> – EPA requests data to support the potential adjustment of the 260 mg/kg total mercury distinction between the high and low mercury subcategories.**

With respect to mercury-bearing *mixed* waste, EPA should eliminate the distinction in the LDR treatment standards that now exists between high mercury and low mercury wastes. For the reasons explained above in Specific Comments V.A, item 1 (p. 6) and V.C.1, item 1 (p. 10), for mixed wastes, there is no apparent justification for requiring that mercury be recovered, regardless of the mercury concentration in the waste. Therefore, DOE suggests that EPA consider establishing new waste subcategories in appropriate waste codes for mercury-bearing mixed wastes, which eliminate the distinction between high and low mercury content. This suggestion is further described in Specific Comment V.C.4, item 1 (p. 13), below.

### V.C.4. Should the Agency Allow Alternative (Non-Recycling) Treatment Options to RMERC for High Mercury Wastes?

1. **<u>p. 28957, col. 2</u> – EPA requests comment on whether treatment options besides recovery should be permissible for high mercury subcategory wastes.**

As has been explained in other comments above, reuse of mercury recovered by roasting and retorting mercury-bearing mixed waste rarely occurs, because such mercury is often contaminated with radionuclides (e.g., cesium) and toxic metals other than mercury (e.g., lead) that may be completely or partially volatilized along with mercury under roasting and retorting conditions. As a result, DOE believes the existing high-mercury LDR treatment standard (i.e., roasting or retorting) is not appropriate for most mercury-bearing mixed wastes. Therefore, DOE is supporting the development of a broader regulatory approach that allows the use of multiple alternative technologies. Specific Comment V.A, item 1 (p. 6) describes several mercury removal/recovery technologies for mixed wastes that are at various stages of investigation. DOE is also investigating non-recovery technologies, some of which are described below in item 2 of this comment
(p. 14).

Since the LDR treatment standard for high mercury wastes (i.e., RMERC) is not appropriate for most mixed wastes, DOE would support adding one or more LDR treatment standards that allow non-recycling options for such wastes. In fact, as has been mentioned in several of the specific comments above, DOE would support LDR treatment standards for mixed wastes that allow multiple options, including mercury recovery technologies, mercury stabilization processes, and mercury removal/separation processes. DOE suggests that to accomplish this, EPA could establish new waste subcategories in appropriate waste codes for mercury-bearing mixed wastes, regardless of its mercury content. The LDR treatment standard for each new waste treatment subcategory would: (1) set a concentration-based treatment standard applicable to treated mercury-bearing mixed waste, regardless of its mercury content; and (2) provide, as alternatives to the concentration-based treatment standard, certain specified technology treatment standards, which could consist of one or more treatment steps, for particular mixed waste streams or categories of mixed waste. EPA could designate the specified technology options based on treatability study and operational data demonstrating the effectiveness and reliability of properly designed and operated technologies for treating particular mixed waste streams or categories of mixed waste.

One of DOE's goals in advocating that specified technology options be included in LDR treatment standards for mercury-bearing mixed wastes is to minimize handling of radioactive materials in order to minimize worker radiation exposures. For this reason, if EPA were to require testing of residues from treatment using the specified technology (i.e., at a facility holding a RCRA permit), then the goal of minimizing radiation exposures would be frustrated. Hence, DOE suggests that once EPA approves a specified technology as an LDR treatment standard option for a particular mixed waste stream or category of mixed waste, an individual treatment facility that has received a RCRA permit for the specified technology, should not be required by that permit to conduct ongoing sampling and analyses of treatment residuals to demonstrate continuing proper operation. Instead, the permit could impose other requirements for demonstrating proper operation, such as certification of compliance with an approved process control program and/or certification of operation within specified parameters that have been previously verified to be consistent with acceptable process performance.

DOE recognizes that under the scheme suggested above, compliance with the concentration-based LDR treatment standard for any mixed waste would have to be demonstrated by sampling and testing in accordance with an approved waste analysis plan. Hence, in some cases, application of the concentration-based LDR treatment standard could result in higher worker radiation exposures than compliance with an alternative specified technology treatment standard because no sampling or testing would be needed to demonstrate compliance with the specified technology standard. Notwithstanding, DOE believes that having the flexibility to choose between concentration-based and specified technology LDR treatment standards for mixed wastes in differing circumstances is important. Having such a choice should improve the ability of mixed waste managers to appropriately balance the costs and benefits of reducing radiation exposures, considering the quantity, radiological characteristics, and circumstances of any mixed wastes that require treatment.

2. **<u>p. 28957, col. 3</u> –EPA requests data on mercury releases from wastes treated by non-recycling technologies that might serve as alternative land disposal treatment standards (e.g., sulfide conversion and stabilization with sulfur-polymer cement).**

**Direct Stabilization.** DOE's MWFA has conducted studies on direct stabilization of mercury-bearing mixed wastes containing mercury concentrations less than 260 mg/kg (see Specific Comment V.A, item 1 (p. 6), above, for information about the MWFA). DOE believes such direct stabilization methods may also be applicable to mixed wastes containing mercury concentrations of 260 mg/kg or greater, including different species of mercury. Three commercial vendors participated in the studies. The summary report is expected to be completed in the fall of 1999, and will be offered to EPA as soon as it is available for release.

**Removal Using Ion-Exchange Resins.** The MWFA also supported studies by two vendors of the ability of specialized ion-exchange resins to remove mercury from liquids and stabilize the mercury for disposal. The Integrated Technology Summary Reports (ITSRs) for these studies are expected to be completed within the next year, and will be offered to EPA as soon as they are available for release.

**Sulfur Stabilization.** DOE is supporting studies on sulfur stabilization of mercury in mixed wastes. One such study involves examining the application of a sulfur polymer cement stabilization process developed at Brookhaven National Laboratory (BNL) (patent pending) to soil samples for which EPA granted a determination of equivalent treatment on July 27, 1998 (see Specific Comment V.C.1, item 1 (p. 10), above). BNL first developed and performed the sulfur polymer cement stabilization and solidification process, with support from the MWFA, on samples of elemental mercury contaminated with

radionuclides.[14] Each elemental mercury sample was mixed with an excess of powdered sulfur polymer cement (SPC) and additives in a vessel and heated for several hours until all of the mercury had been converted into mercuric sulfide (HgS). Additional SPC was then added and the temperature of the mixture raised, resulting in a homogeneous molten liquid which was poured into a suitable mold where it could cool and solidify. Final waste form products produced from initial bench scale tests resulted in TCLP mercury concentrations significantly lower than 0.2 mg/l.

Studies of other methods for stabilizing mercury in mixed wastes using sulfur are also under way within the DOE complex. Data from ongoing sulfur stabilization studies are expected to be compiled within the next year. When such compilations have been analyzed and are available for release, they will be offered to EPA.

**Mercury Amalgamation Solidification/Stabilization (MASS).** A stabilization technique called mercury amalgamation solidification/stabilization (MASS), developed by the Materials Technology Group, Chemical Technology Division at Oak Ridge National Laboratory, has been successful at stabilizing mercury and mercury compounds with untreated mercury concentrations well above 260 mg/kg so that mercury leached from the treated material during the TCLP is less than 0.20 mg/l (see Figure 1). The left bar in each bar pair on Figure 1 represents the log of the TCLP extract concentration (mg/l) for an untreated test material containing the given total mercury amount and mercury species. The right bar of each bar pair represents the log of the TCLP extract concentration (mg/l) for the MASS treated material. Some unique features of the MASS technique are:[15]

a. It stabilizes both elemental mercury or soluble mercury compounds;
b. It minimizes the mercury vapor pressure inside the waste form;
c. It controls the oxygen potential inside the waste form to prevent oxidation of the amalgamating agents; and
d. It solidifies the stabilized mercury, other RCRA metals, and radionuclides inside a cementitious waste form.

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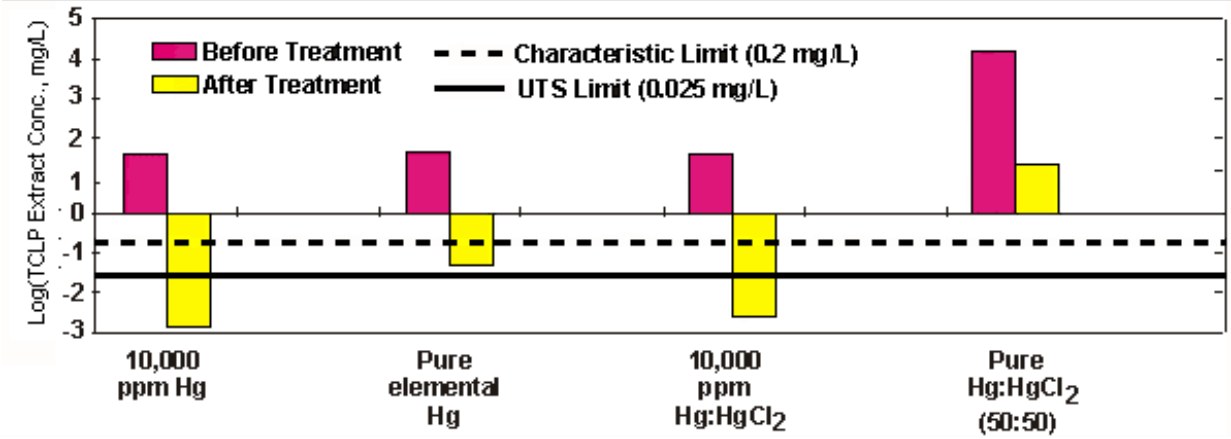
[14] See Melamed, D., et al., "Sulfur Polymer Cement Stabilization of Elemental Mercury Mixed Waste," Brookhaven National Laboratory Informal Report, BNL-65833, April 1998. [Available via Internet: http://gpo.osti.gov:901; search for document identification number BNL--65833]

[15] See http://www.ornl.gov/divisions/ctd/Eng_Dev/capabilities/tmg1.htm

**Figure 2**: **Concentrations of Hg in TCLP Leachate Before and After MASS Treatment**




**V.C.6. Should EPA Consider Revising the Debris Standards To Require That High Mercury Subcategory Wastes That Also Meet the Definition of Debris Be Retorted?**

1. **<u>p. 28957, col.3</u> – EPA requests comment on whether the LDR treatment standards for hazardous debris listed in Table 1 of 40 CFR 268.45 should be revised to require the roasting or retorting of hazardous debris if the mercury concentration is greater than or equal to 260 mg/kg total mercury.**

DOE would oppose revising Table 1 of 40 CFR 268.45 to require the roasting or retorting of hazardous debris if the mercury concentration is greater than or equal to 260 mg/kg total mercury, but would support standards that continue to allow roasting/retorting (without recycle of the recovered mercury) as an alternative for mixed waste debris treatment independent of initial mercury concentration. Representative sampling of debris to ascertain total metal content is extremely difficult. Therefore, assigning debris to low mercury and high mercury categories to determine the applicability of a requirement to retort would be a burden for generators and treaters. DOE believes this would be a particular burden in the case of radioactive mercury-bearing debris. Thus, if EPA decides to prescribe retorting for mercury-bearing debris (at greater than 260 mg/kg or some other threshold level), DOE requests that consideration be given to providing other options for *radioactive* mercury-bearing debris (i.e., mercury-bearing mixed debris). Specific Comment V.C.4, item 1 (p. 13), above, describes a suggested approach for all mercury-bearing mixed waste, including mixed debris, that DOE urges EPA to consider.

**VI. Mercury Treatment Technologies – Incineration of Mercury Wastes**

**VI.D. General Waste Characterization Data on Mercury in Hazardous Waste Streams**

1. **<u>p. 28958, col. 3 - p. 28959, col. 1</u> – EPA explains that the Biennial Report System database, which would be used if the Agency were to amend the LDR treatment standards, does not distinguish between the high and low mercury subcategories. EPA also notes that certain**

**D009 waste streams, such as waste streams containing PCBs, may be incinerated for reasons other than the LDR IMERC treatment requirement.**

As noted in Specific Comment III.B, item 1 (p. 4), above, DOE expects large quantities of media and debris contaminated with mercury and radionuclides to be generated as a result of remedial activities at DOE sites. While quantitative information is not available, DOE anticipates that some portion of these materials also will contain organics and PCBs, which presently require treatment by incineration.

## VI.G. Request for Comment

### VI.G.1 What Mercury Waste Streams Will Continue to Warrant IMERC?

1. **<u>p. 28960, col. 1</u> – EPA requests information on mercury-bearing wastes that may continue to require incineration.**

DOE has many small volume, high-mercury waste streams that are primarily organic and/or contain organic hazardous constituents that warrant incineration. Additionally, as was mentioned in Specific Comment III.B, item 1 (p. 4), above, contaminated media and remediation debris resulting from DOE site remedial actions may contain organics and/or PCBs, as well as mercury and radionuclides. Incineration is currently the best, most robust, available method for destroying organic matrices and organic contaminants when they are present in mixed wastes. Therefore, DOE requests that EPA not adopt an LDR treatment standard applicable to mixed waste that would prohibit incineration of any such mixed waste streams.

2. **<u>p. 28960, col. 1</u> – EPA requests comment on the feasibility of requiring the separation of mercury-bearing solids from organic wastes and identification of any wastes for which such pretreatment would not be feasible.**

DOE is currently sponsoring feasibility studies on separating mercury-bearing solids from selected organic wastes. However, thus far, DOE has found that to be successful in comparison to incineration, separation technologies frequently require greater limitations on waste feed characteristics and throughput, which requires more detailed characterization and more feed preparation steps. Therefore, DOE has narrowed the treatability studies to only mixed wastes with characteristics likely to be compatible with the separation technology being evaluated. DOE expects these studies to be completed during the next year and will offer the results to EPA when they are available for release.

### VI.G.2. What Alternative Technologies Are Available To Treat Mercury Wastes Containing Organics While Also Minimizing Mercury Emissions?

1. **<u>p. 28960, col. 2 and p. 28962, col. 1</u> – EPA seeks waste characterization and technology performance data on alternative technologies for the treatment of wastes that are currently incinerated because mercury emissions from incinerators may be costly to control.**

DOE is studying alternative technologies to treat organics in specific mixed wastes. For example, the Lawrence Livermore National Laboratory (LLNL) has studied and developed the direct chemical oxidation (DCO) process. DCO is a nonthermal, near ambient (atmospheric) pressure, aqueous-based process that uses a solution of peroxydisulfate at less than 100°C to convert organic solids and liquids to benign carbon dioxide, water, and constituent minerals. A broad spectrum of materials has been

successfully oxidized using DCO, and a pilot-scale mixed waste treatment demonstration is being contemplated.[16] Another example is the Acid Digestion Process, which has been developed and demonstrated at the DOE's Savannah River Site (SRS). Acid Digestion is an oxidative destruction technology for organic constituents of mixed waste, which uses nitric acid in a phosphoric acid carrier at less than 200°C and atmospheric or moderate pressures. Past experimental work has advanced Acid Digestion technology toward demonstrating viability as a production-scale system.[17]

In addition to the studies described above, a proprietary alternative organic destruction technology using $HCl/FeCl_3$ is in progress. A report may be issued within the next two years. The study results will be offered to EPA when they are available for release.

## VII. Regulatory Options Involving Source Reduction

1. **<u>p. 28960, col. 3</u> – EPA is seeking comment on potential regulatory incentives that would encourage companies to invest in manufacturing process redesign, raw materials substitution or other technologies that would reduce the amount of mercury found in hazardous waste.**

As DOE indicated in comments on the draft EPA Action Plan for Mercury,[18] DOE believes EPA should encourage process improvements for manufacturing and R&D that would reduce or eliminate the use of mercury in manufacturing, R&D, and other processes and remove excess mercury from feed materials. Absent a regulatory incentive, permittees may not consider such pollution prevention methods, especially if the technology is not well known or is expensive to install or operate. Thus, DOE generally supports EPA's effort to fashion innovative LDR treatment standards that provide incentives for companies to use such technologies and other mercury pollution prevention methods in order to reduce the amount of mercury in the wastes generated. However, most of DOE's mercury-bearing mixed wastes are not amenable to source reduction either because the wastes already exist, or because they will be generated from cleanup of existing contamination.

## VIII. Mixed Wastes

1. **<u>p. 28961, col. 1</u> –The preamble mentions that DOE's MWFA Mercury Working Group, in conjunction with EPA, has initiated studies of the direct treatability of high mercury-inorganic subcategory wastes for direct disposal.**

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[16] DOE Mixed Waste Focus Area, *Direct Chemical Oxidation*, Innovative Technology Summary Report, DOE/EM-xxxx, July 1999.
[Available via Internet: http://wastenot.inel.gov/mwfa/dco.pdf]

[17] DOE Mixed Waste Focus Area, *Acid Digestion of Organic Waste*, Innovative Technology Summary Report, DOE/EM-xxxx, OST Reference #1827, July 1998.
[Available via Internet: http://wastenot.inel.gov/mwfa/acid.pdf]

[18] DOE letter from Office of Environmental Policy and Assistance to OPPT Document Control Officer dated February 12, 1999, in regard to notice of availability and solicitation of public comments on the draft Multimedia Strategy for Priority Persistent, Bioaccumulative and Toxic Pollutants and draft Action Plan for Mercury (63 <u>FR</u> 63926; November 17, 1998).

DOE's D009 mixed waste inventory has been decreasing for two reasons. First, DOE continues to make progress in treating mercury-bearing mixed wastes. Second, DOE conducts ongoing detailed testing of stored mixed wastes. The results of such testing indicate that some wastes were conservatively (and incorrectly) coded in the D009 category when placed into storage.[19] Since actual test results now show that these wastes do not really exhibit the toxicity characteristic for mercury, DOE has modified the inventory by removing certain wastes from the D009 category.

Notwithstanding recent decreases in the quantity of mixed waste reported as D009 waste in DOE's mixed waste inventory, DOE is concerned that potentially large quantities of mercury-bearing mixed waste may be generated in the future (i.e., quantities that are much greater than current mercury-bearing mixed waste inventory quantities). As stated earlier in this comment package, remedial actions and D&D at DOE sites are a potentially significant source of such mercury-bearing mixed waste. Other anticipated sources, also mentioned earlier in this comment package, include the Spallation Neutron Source and emission control systems designed to meet the MACT standards for mercury and dioxin/furans on incinerators treating organic mercury-bearing mixed wastes to meet the LDR treatment standards. DOE has previously advised EPA of this later potential mercury-bearing mixed waste source in response to other rulemaking notices.[20]

As EPA is aware, to address issues associated with treatment of future quantities of mercury-bearing mixed waste, as well as other technical issues about regulation of mixed waste treatment facilities, EPA and DOE formed the National Technical Workgroup (NTW) on Mixed Waste Treatment [21] under an interagency agreement initiated in 1991. The NTW is composed of representatives from EPA, DOE, State regulatory agencies, DOE contractors, and private mixed waste treatment organizations. In 1998, the NTW was asked to coordinate development of joint EPA and DOE research efforts related to treatment of mixed waste.

2. **<u>p. 28961, col 2.</u> – EPA specifically requests comments on eliminating the RMERC standard for mixed mercury wastes, and on allowing the use of alternative technologies that are currently being investigated by EPA and DOE, with the residuals having to comply with a numerical limit.**

As discussed in Specific Comment V.C.3, item 1 (p. 13), above, DOE believes the current distinction in the LDR treatment standards now applicable to high mercury and low mercury mixed wastes should be eliminated. Further, as indicated in Specific Comment V.C.4, item 1 (p. 13), above, DOE supports replacing the IMERC and RMERC LDR treatment standards for high mercury mixed waste and the concentration-based LDR treatment standard for low mercury mixed waste with an alternative standard applicable to all mercury-bearing mixed wastes regardless of their mercury content. As was explained in

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[19] Due to worker radiation protection and analytical concerns associated with analyzing radioactive materials, some mixed wastes were conservatively recorded and stored as D009 wastes based on process knowledge.

[20] See: (1) DOE Comments on Hazardous Waste Combustors; Revised Standards Proposed Rule (61 <u>FR</u> 17358; April 19, 1996), September 23,1996, General Comment 2 and Specific Comment 4.III.A.3.a; and (2) DOE letter from R. Pelletier to E. Cotsworth dated May 23, 1997, and its Enclosure 4, "Radioactive Mixed Waste and Land Disposal Restrictions (LDR) Standards for High Mercury -Inorganic Subcategory Wastestreams," May 23, 1997.

[21] See http://www.ntw-mixedwaste.org

that comment, DOE would support LDR treatment standards for mixed wastes that allows multiple options, including mercury recovery technologies, mercury stabilization processes, and mercury removal/separation processes. As this implies, DOE would oppose establishing an LDR treatment standard for mixed waste that would preclude treating certain mercury-bearing mixed waste using incineration or retorting.

DOE suggests that to develop LDR treatment requirements allowing multiple options for treating mercury-bearing mixed wastes, EPA could establish new waste subcategories in appropriate waste codes for mercury-bearing mixed wastes, regardless of its mercury content. The LDR treatment standard for each new waste treatment subcategory would: (1) set a concentration-based treatment standard applicable to treated mercury-bearing mixed waste, regardless of its mercury content; and (2) provide, as alternatives to the concentration-based treatment standard, certain specified technology treatment standards, which could consist of one or more treatment steps, for particular mixed waste streams or categories of mixed waste. EPA could designate the specified technology options based on treatability study and operational data demonstrating the effectiveness and reliability of properly designed and operated technologies for treating particular mixed waste streams or categories of mixed waste.

## IX. Discussion of Alternative Treatment Technologies

### IX.A. Possible Alternative Technologies to Retorting

1. **<u>p. 28961, col. 3 - p. 28962, col. 1</u> -- EPA requests information about removal/recovery technologies and immobilization technologies that hold promise as alternatives to retorting.**

Specific Comment V.A, item 1 (p. 6), above, describes some mercury recycling (removal/recovery) technologies, other than retorting, the development of which DOE has supported. Included are the medium-temperature thermal desorption process being developed by Mercury Recovery Services, Inc.; the General Electric Mercury Extraction Process (GEMEP℠); and the Polymer Filtration Process being developed at Los Alamos National Laboratory. Specific Comment V.C.4, item 2 (p. 14), above, discusses some non-recycling (immobilization) technologies, the development of which DOE also is supporting. Included are direct stabilization; removal using ion-exchange resins; sulfur polymer cement stabilization; and Mercury Amalgamation Solidification/Stabilization (MASS) being developed at Oak Ridge National Laboratory. DOE expects to offer additional information about these and other recycling and non-recycling technologies to EPA when it is available for release.

### IX.B. Possible Alternative Technologies to Incineration

1. **<u>p. 28962, col. 1</u> – EPA requests information about technologies that may be used in place of IMERC to treat high mercury wastes currently requiring incineration.**

Destruction by incineration and other types of combustion is the most common and robust method currently used to treat mixed wastes containing hazardous organic constituents (e.g., PCBs). However, DOE is evaluating this practice, and is supporting investigations into possible alternative technologies for

certain mixed waste streams. For example, preliminary information is provided in the document titled "Evaluation of Alternative Nonflame Technologies for Destruction of Hazardous Organic Waste."[22]

DOE is demonstrating and further evaluating chemical oxidation of organics, for example, the process described in "Treatment of Tritiated Mixed Waste by Catalytic Oxidation."[23] This paper, a copy of which is attached for reference to these comments, assesses treatment technologies that convert tritiated organic compounds to simple chemicals such as water and carbon dioxide. DOE needs to use such a process in the case described by the paper in order to allow capture of tritium-bearing emissions. The paper reviews existing technologies and concludes that treatment of tritiated mixed waste by catalytic chemical oxidation (CCO) is appropriate. After characterizing mixed tritiated waste, studies were performed to successfully demonstrate the feasibility of CCO for its treatment. The study demonstrates that CCO (as designed and constructed by the authors) can successfully treat a variety of tritiated mixed wastes meeting requirements of EPA and the State of California. However, at the process temperatures used, some volatilization of mercury can still be expected. Other information about alternative oxidation technology is provided in Specific Comment VI.G.2, item 1 (p. 17), above.

Data from additional studies, including certain mercury removal methodologies, should be available within the next year and will be offered to EPA when they are available for release.

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[22] Schwinkendorf, W. E., et al., "Evaluation of Alternative Nonflame Technologies for Destruction of Hazardous Organic Waste," INEL/EXT-97-00123, April 1997. [Available via Internet at: http://wastenot.inel.gov/mwfa/acrobat/nonflame.pdf]

[23] Chang, L., et al., "Treatment of Tritiated Mixed Waste by Catalytic Oxidation," *Technology: Journal of the Franklin Institute*, Vol. 334A, 1997, pp. 205-213.