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INVITED SPEAKER

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Chairman: L. Stirling

OPENING COMMENTS OF SESSION CHAIRMAN STIRLING

DOE WASTE MANAGEMENT PROGRAM - CURRENT AND FUTURE
Joseph A. Coleman

OPENING COMMENTS OF SESSION CHAIRMAN STIRLING

I am pleased to introduce the speaker for this afternoon's session on Wastes. Dr. Joseph Coleman is eminently qualified to speak on the topic. He has received degrees from the University of Rhode Island, Berkeley, and the University of Washington in chemical and nuclear sciences. He has worked in the field of radiation effects on materials and microelectronic technology at the Bell Telephone Laboratories. He directed programs dealing with civilian nuclear waste management issues. He has also worked on solidification of high-level wastes stored at the former spent nuclear fuel reprocessing plant at West Valley. Presently, he is responsible for various cross-cutting technical issues related to the management of DOE wastes.

DOE WASTE MANAGEMENT PROGRAM-CURRENT AND FUTURE

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Abstract

The back end of the nuclear fuel cycle, as well as many operations in the Department of Energy, involve management of radioactive and hazardous waste and spent nuclear fuel. Described herein is the Department's Waste Management Program - where we are and where we're going - and general information about the Program for managing and disposing of waste that will illustrate the importance of air cleaning and treatment in assuring protection of the public and our environment.

The Office of Environmental Restoration and Waste Management

In 1989, the Department of Energy (DOE) committed to a 30-year goal of compliance and cleanup of its nuclear sites. That is, by the year 2019, DOE would clean up the 1989 inventory of inactive sites and facilities and, on a much faster track, bring its nuclear-related sites and facilities into compliance with applicable Federal, State, and local laws and regulations. Before the creation of the Office of Environmental Restoration and Waste Management (EM), no single DOE focal point existed for such activities. Programs responsible for these activities were spread among three principal organizational elements--Defense Programs, Nuclear Energy, and Energy Research. The absence of a consolidated management approach reflected the relative priority for nuclear waste-related compliance and cleanup and impacted DOE's response to increasingly numerous and strict environmental requirements.

In that same year, the Secretary of Energy announced a resetting of priorities in DOE to reflect environmental compliance and cleanup as more heavily weighted than nuclear materials and weapons production. To implement the Secretary's vision of environmental stewardship, EM was created to consolidate DOE-wide responsibility for compliance and cleanup and waste management (Figure 1). The existence of EM also assures that a top level of management will coordinate these activities within DOE's new culture of accountability in the areas of environment, safety, and health.

EM Structure and Responsibilities

EM consists of three programmatic offices and two support offices. Figure 2 shows EM's position within DOE.

The Office of Waste Management (OWM) has program responsibility for waste management at all DOE sites. Principal waste management functions include the treatment, storage, and disposal of several types of waste: high-level radioactive waste; transuranic radioactive waste, low-level radioactive waste; chemically hazardous waste; mixed waste made up of radioactive waste combined with hazardous waste; and sanitary waste. Waste minimization efforts for all DOE activities are also coordinated from this Office.

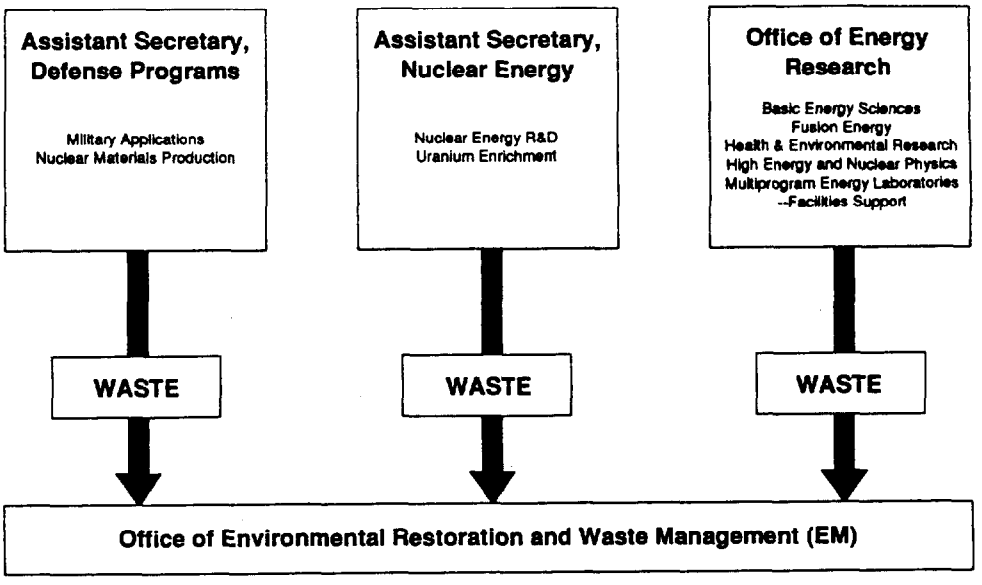
The Office of Environmental Restoration (OER) manages the cleanup of hazardous and radioactive waste at some 110 sites in 32 states, and several sites off-shore. Principal environmental restoration functions include site remedial action and facility decontamination and decommissioning (D&D). Remedial action comprises all aspects of the assessment and cleanup of known and suspect inactive release sites. D&D is concerned with the safe caretaking of surplus nuclear facilities and their decontamination and entombment, or dismantling and removal. The waste produced from environmental restoration activities falls under the management responsibility of OWM.

The Office of Technology Development (OTD) has the responsibility to develop technologies to resolve major technical issues and satisfy emerging requirements for Environmental Restoration and Waste Management Programs. These technologies support efforts to minimize the toxicity and volume of waste; manage unavoidable waste more efficiently and safely; monitor and reduce the release of effluents; achieve cost-effective and safer remediation of sites and facilities; and achieve environmentally acceptable, permanent disposal of waste within regulatory guidelines. OTD is currently supporting work in the areas of off-gas monitoring and treatment, and filter development, topics that have been discussed earlier in this conference.

OWM Manages The Following Categories of Waste.

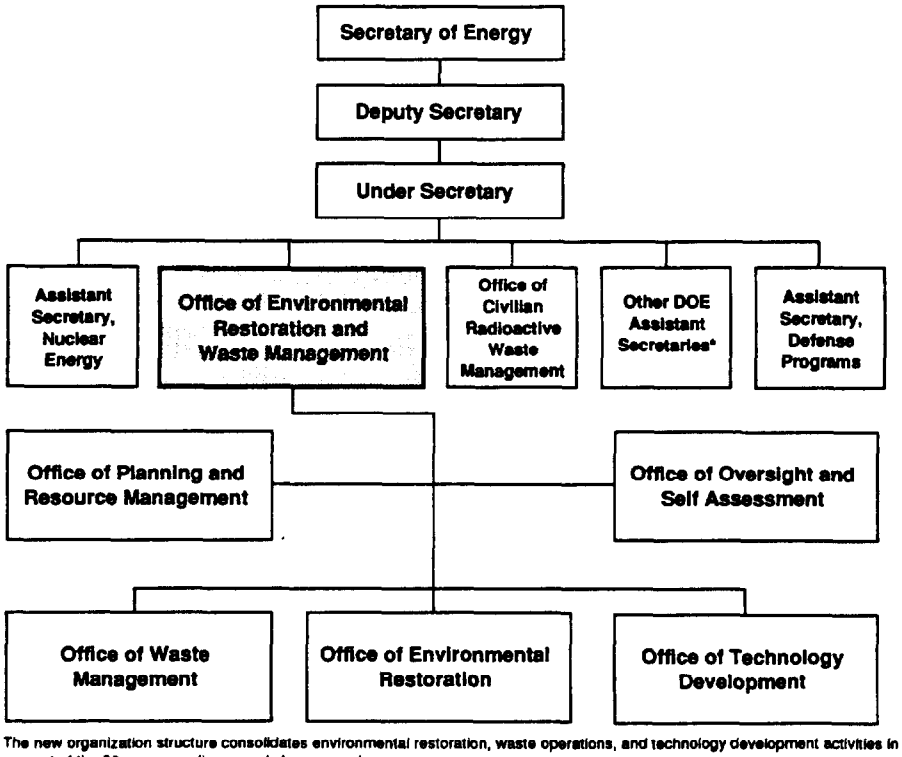
HIGH-LEVEL WASTE (HLW) is highly radioactive waste material resulting from the reprocessing of spent nuclear fuel. It includes liquid waste produced directly in reprocessing and solid waste derived from the liquid. Some HLW contains elements that decay very slowly and remain radioactive for thousands of years. Most HLW must be handle by remote control from behind protective shielding. Spent nuclear fuel (SNF) permanently discharged from DOE reactors and civilian nuclear power plants is managed much the same as HLW for storage and disposal.

Management of Waste from Past and Current DOE Nuclear Programs Has Been Consolidated.



DOE's major nuclear programs generate waste. EM is responsible for managing this waste.

Figure 1



The new organization structure consolidates environmental restoration, waste operations, and technology development activities in support of the 30-year compliance and cleanup goal.

* These include the Assistant Secretaries for: Fossil Energy; Conservation and Renewable Energy; Environment, Safety, and Health.

Figure 2

TRANSURANIC WASTE (TRUW) is mostly LLW contaminated with alpha-particle-emitting isotopes which have decay rates and concentrations exceeding certain specified levels. It is produced during reactor fuel assembly, nuclear weapons fabrication, and fuel reprocessing operations. It contains man-made elements with atomic numbers greater than 92, thus the name trans (or beyond) uranic (uranium). TRUW decays slowly and requires long-term isolation from the environment. Protective clothing, equipment, and tools may be contaminated with TRU radionuclides. Approximately 2% of TRUW must be handled remotely.

LOW-LEVEL WASTE (LLW) is radioactive waste that is not high-level waste, transuranic waste, spent nuclear fuel, or byproduct material (e.g., uranium mill-tailings). It is generated in a variety of operations including uranium enrichment processes, reactor operations, isotope production, medical diagnostic procedures, and research and development projects. It is typically contaminated with small amounts of radioactivity dispersed in large amounts of material. LLW is usually rags, papers, filters, tools, equipment, and discarded protective clothing contaminated with radionuclides. Approximately 3% of LLW requires a limited amount of shielding during handling and transportation activities.

HAZARDOUS WASTE is waste that exhibits toxic, corrosive, reactive, or ignitable characteristics that can affect human health and/or damage the environment. Hazardous waste includes chemicals, such as chlorinated and nonchlorinated hydrocarbons, explosives, gasoline, diesel fuel, asbestos, acid, organic solvents, metals, and pesticides. As in private industry, DOE must comply with strict Federal, State, and local environmental regulations in treating and disposing of hazardous waste.

MIXED WASTE is waste which exhibits both radioactive and hazardous characteristics. Treatment standards and disposal facilities are being developed for mixed waste to satisfy requirements for both the hazardous components regulated by EPA and the radioactive components regulated under the Atomic Energy Act.

SANITARY WASTE is waste that is not categorized as radioactive or hazardous. This waste is normally acceptable for disposal in sanitary landfills. Sanitary waste includes liquids which are treated in sewage treatment plants. New EPA requirements have recently been issued which will require lining of the landfills, off-gas/air monitoring and collection and monitoring of ground run-off.

Waste Management

Waste management embraces ongoing DOE-wide activities whose purpose is to characterize, package, transport, treat, store and dispose of DOE waste in an environmentally sound and cost-effective manner. Achieving these goals yields two benefits. It protects people and the environment today and in the future and helps avoid the creation of additional waste sites.

The scope of waste management includes the stored or "legacy" waste from past operations, new waste produced by DOE's defense and civilian programs, and future waste expected from programs with significantly changed missions. This includes constructing and operating treatment, storage and disposal facilities and sites, establishing necessary policy and guidance for waste operations and performing the related integrated and long-range planning. Waste management sites are shown in Figure 3.

Waste Minimization

In addition to managing waste materials on a daily basis, another primary mission of OWM is to provide policy and guidance and coordinate an effective DOE-wide waste minimization program that achieves significant reductions in the volume and toxicity of DOE wastes. Waste minimization programs are underway at all DOE sites and facilities to assist the waste generators with detailed planning and implementation.

Although often perceived as reduction in waste volume and concentration, true waste minimization must be seen as avoidance of the future generation of waste. Waste minimization is becoming one of the highest priority initiatives within the Department. Waste minimization technology is the most interdisciplinary of the waste management tools, affecting all present and proposed DOE operations. Establishing a waste minimization program requires cultural as well as technical changes throughout the DOE complex.

The objective of our waste minimization program is to achieve a significant, near-term reduction in manufacturing waste generation using material substitution, process alteration, new production hardware, and recycling. A comprehensive waste minimization program contributes to decreases in waste treatment, storage, and disposal costs and lower health risks to workers and the public. Technical approaches are being sought to (1) reduce the number of production operations required; (2) increase the use of nonhazardous chemicals and chemicals that produce waste compatible with the environment; (3) increase the use of recyclable chemicals and materials; and (4) design new products, processes, and facilities or redesign existing ones to

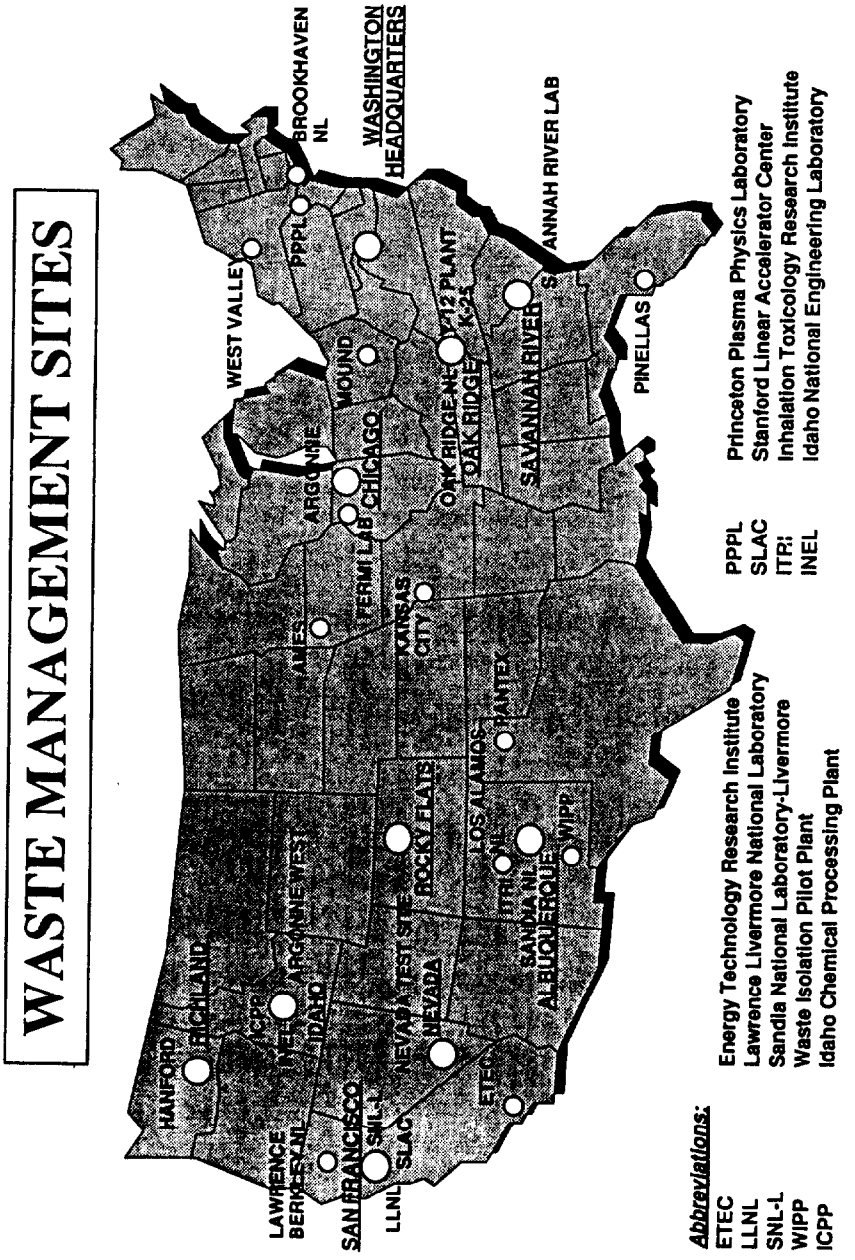

WASTE MANAGEMENT SITES
HANFORD
RICHLAND
IDAHO
INEL
ARGONNE WEST
ICPP
LAWRENCE BERKELEY NL
SAN FRANCISCO
SNL-L
LLNL
SLAC
NEVADA TEST SITE
NEVADA
ROCKY FLATS
ETEC
LOS ALAMOS NL
ITRI
SANDIA NL ALBUQUERQUE
WIPP
HANTEX
AMES
FERMI LAB
ARGONNE
CHICAGO
MOUND
WEST VALLEY
KANSAS CITY
OAK RIDGE NL
OAK RIDGE
Y-12 PLANT
K-25
BROOKHAVEN NL
PPPL
WASHINGTON HEADQUARTERS
SAVANNAH RIVER
SAVANNAH RIVER LAB
PINELLAS
Abbreviations:
ETEC Energy Technology Research Institute
LLNL Lawrence Livermore National Laboratory
SNL-L Sandia National Laboratory-Livermore
WIPP Waste Isolation Pilot Plant
ICPP Idaho Chemical Processing Plant
PPPL Princeton Plasma Physics Laboratory
SLAC Stanford Linear Accelerator Center
ITRI Inhalation Toxicology Research Institute
INEL Idaho National Engineering Laboratory

Figure 3

generate less waste. Some criteria to determine a successful technology include equivalent or improved processing yield, reduced quantities of scrap, reduced waste processing of byproducts, reduced use of hazardous chemicals, positive return on investment, and no loss of product quality.

Treatment, Storage and Disposal

Reference has been made several times to treatment, storage, and disposal.

Treatment

Treatment includes the methods, techniques or processes designed to change the physical or chemical character of waste to reduce the volume or toxicity of the material and make it safer and easier to handle, store, and dispose. Selection of treatment methods depends on the quantity and form of the waste material and the conditions, or requirements, for storage and disposal.

In general, liquid waste is treated by incineration, vitrification, or other thermal processes and non-thermal stabilization (e.g., grouting); solid waste can be reduced through processes such as compaction, incineration, melting, and acid digestion.

Waste processing or vitrification plants take high-level liquid waste or sludge and convert it to a waste form suitable for permanent disposal in a geologic repository. Liquid waste can also be solidified by oxidation and removing moisture (calcining). Calcined material and sludge can be immobilized by mixing it with molten glass particles.

Treatment or conditioning of spent nuclear fuel to meet disposal requirements will be evaluated in the next few years; methods are likely to be varied in view of the many different fuel types in the DOE inventory.

TRUW is currently stored pending availability of disposal capacity.

The principle LLW treatment methods are volume reduction (e.g., compaction, incineration) and solidification.

DOE's near-term strategy is to use commercial facilities to treat and dispose of hazardous waste as it is generated.

For mixed waste, a number of thermal treatment and non-thermal stabilization (e.g., cement) facilities exist or are in the planning, construction, or startup phase. A few mixed waste treatment standards have been established; for example, standards exist for mixed waste containing mercury, lead, powdered zirconium, and high-level radioactive waste.

Storage

Storage is the retrievable retention of waste pending disposal, an interim measure. OWM strategy includes elimination of the backlog of stored waste and reducing the generation of new waste. Before it is solidified, high-level radioactive waste is stored in liquid form in carbon-steel tanks encased in concrete. These tanks have capacities ranging from 500,000 to about 1,000,000 gallons and most provide two separate tanks with a space between them for detecting and cleaning up potential leaks. HLW is also stored as calcined material in stainless steel containers. The main storage sites for DOE HLW are Hanford, Savannah River, and Idaho. On the basis of volume, Hanford has approximately twice the amount of the others combined. Storage of SNF is either dry or wet (e.g., water, sodium) in shielded cells or basins.

A large amount of DOE's present inventory of TRUW (75%) has been disposed in near-surface sites. New TRUW is no longer buried but stored in containers and stacked on asphalt or concrete pads. Current strategy is to upgrade and maintain safe storage at the generator sites and assure that storage complies with RCRA requirements.

Storage of DOE LLW is normally on a temporary basis; the acceptability for disposal of most LLW eliminates the need for long-term storage. LLW will continue to be disposed of using proven or improved surface or near-surface techniques at selected DOE locations. The LLW is characterized to make sure it does not contain hazardous material and stored for the short term awaiting transportation, treatment, or disposal on-site. Small LLW generators will ship to the major DOE sites.

Hazardous waste is stored in permitted DOE facilities pending shipment to treatment and disposal sites. Compliance with land disposal restrictions (LDR's) ensures that hazardous waste is stored and disposed according to specific regulatory provisions in preparation for treatment.

Mixed waste is stored pending treatment and disposal. DOE has over 280 storage units located at 33 sites that store LLMW. Those units include container storage, aboveground tanks, underground storage tanks, waste piles, and surface impoundments. Overall management of

LLMW is complicated by the fact that RCRA regulations impose not only land disposal restrictions but also restrict the length of time that untreated mixed waste may be stored.

Disposal

Disposal is the permanent emplacement of waste in a way that assures its isolation from the human environment for the foreseeable future with no intent of retrieval. OWM determines the technologies and processes to prepare DOE waste for permanent disposal. Facilities are being designed, built, and tested so processing and disposal of stored waste can proceed aggressively.

HLW and SNF are expected to be disposed in a Federal repository, the first of which is proposed to begin operations after the year 2000. In 1987, the U.S. Congress designated Yucca Mountain, near the Nevada Test Site, as the site to be studied by DOE for possible development as a repository. Yucca Mountain offers an extremely dry location, a very deep water table (1,700 feet), and a solid rock formation known as "welded tuff" (a dense form of compacted volcanic ash).

A facility for disposal of TRUW from defense operations has been completed near Carlsbad, New Mexico. Operation of the Waste Isolation Pilot Plant (WIPP) is pending legislation to transfer the land from the Department of the Interior to DOE and completion of test demonstrations. Examination and processing facilities at various DOE sites will certify that TRUW shipments meet the criteria for disposal at WIPP.

LLW is generally disposed by shallow land burial in trenches. New technologies, stabilization techniques, and site monitoring systems are being evaluated to ensure safety and protection of the environment. There are presently six major DOE sites that dispose of LLW either generated on-site or received from smaller DOE generator sites.

DOE currently disposes of hazardous waste in permitted commercial facilities.

Other Waste Management Functions

There are other key waste management functions involved in dealing with DOE waste: packaging, transportation, and characterization. These are self-descriptive to a large degree. While important they are mainly supportive of the big three: treatment, storage and disposal. One of the most widely expressed technology needs by waste management operators in the field is for ways to better characterize the waste

that they receive from generators. A great deal of effort is underway in DOE to develop improved capabilities for waste characterization.

Waste Type Status

A summary of waste management strategies for the various DOE waste types is provided below (Figure 4).

MAJOR EM WASTE CATEGORIES

- **High-Level Waste* (HLW)**
- **Transuranic Waste* (TRU)**
- **Low-Level Waste* (LLW)**
- **Low-Level Mixed Waste* (LLMW)**
- **Hazardous Waste (HAZW)**
- **Sanitary Waste (SANW)**

* RADIOACTIVE

Figure 4

High-Level Waste

The main DOE storage sites for some 400,000 cubic meters of HLW are at Hanford (64%), Savannah River (33%), and Idaho (3%). The strategy for HLW is to upgrade the existing storage tanks and maintain safe storage, and begin treatment to convert it to a form suitable for permanent disposal in a deep geologic repository.

Within DOE, EM is responsible for treatment of the HLW and the Office of Civilian Radioactive Waste Management is responsible for disposal under the Nuclear Waste Policy Act as amended. Similar arrangements apply to SNF. EM's involvement in the management of SNF is a fairly recent development as DOE has determined that reprocessing is no longer needed to recover material for defense-related needs.

Transuranic Waste

Most of DOE's TRUW is buried or stored at four DOE sites, Hanford, Idaho, Los Alamos and Savannah River, with the majority located at Hanford and Idaho. Approximately 75% of the total amount is buried.

The DOE strategy is to make sure the material is stored safely at the generation sites in compliance with AEA and RCRA requirements until the WIPP test phase is completed.

Low-Level Waste

The Department has disposed on the order of 2.7 million cubic meters of LLW at six major sites within the complex with the largest percentages located at Savannah River (22%), Hanford (21%), Oak Ridge (10%) and the Nevada Test Site (15%). The DOE strategy with LLW is to characterize it to make sure it does not contain hazardous material, and treat it if necessary for disposal on-site or for short term storage if the waste is to be shipped to another DOE site for disposal. As a matter of policy, the smaller DOE LLW generators ship to the major sites for disposal.

Hazardous Waste

Currently, DOE has limited on-site hazardous waste management capabilities, depending heavily on commercial hazardous waste management facilities for the treatment and disposal of DOE-generated hazardous waste. It is estimated that between calendar years 1984-1991, DOE generated over 100,000 cubic meters of hazardous waste. During this time frame the Kansas City Plant generated 57% of the waste.

One of the recent issues facing OWM is the hazardous waste shipping moratorium imposed in 1991. The moratorium prohibits shipment of hazardous wastes to commercial hazardous waste management vendors pending review and approval of shipping procedures by Headquarters.

Low-Level Mixed Waste

Regulatory provisions based on the RCRA and the AEA have complicated LLMW management at DOE. RCRA prohibits the land disposal of specified hazardous wastes according to a phased schedule unless either the wastes are treated to specified treatment standards or other requirements, or a demonstration is made to the EPA that "there will be no migration of hazardous constituents from the disposal unit for as long as the wastes remain hazardous." RCRA also prohibits the long-term storage of RCRA-regulated hazardous wastes.

Inventories reported as of March 1992 identify some 750 LLMW streams from 37 DOE sites, with wastes stored at all but three of these sites. Continued generation is anticipated for some 380 of these waste

streams at 33 generator sites. Reliable estimates for LLMW generated from environmental restoration activities have not been identified and are not included in this compilation of waste streams. About 75% percent of the LLMW is at three DOE sites, Idaho, Oak Ridge and Hanford.

Sanitary Waste

DOE facilities and sites generate both liquid and solid sanitary waste. EM has focused primarily on management of solid sanitary waste. The EM program includes complying with new EPA requirements recently issued.

Summary

The scope and complexity of the Department's Waste Management Program described in this paper should make clear the tie between the Program and the subject matter of this conference. For example, capability for monitoring and control of effluents is particularly important for waste treatment operations and facilities. Reactor and fuel cycle facilities need to be designed and operated with the view of minimizing waste produced and assisting in the eventual decommissioning of the facilities. The sharing of information and technology in conference such as this is important to the nation's initiatives in the waste management area.

DISCUSSION

FIRST: Where do you see the need for new gas cleaning technology in this program? Is the need in place, or is a major research and development program specifically related to waste disposal needs now required? As you are well aware, the codes and standards for nuclear air and gas cleaning have been developed for the civilian nuclear power plant industry. They are now being forced-fitted into the rather different requirements of the program which you have just described so well. The second question is, will the current codes and standards be adequate for the very different requirements that you have described?

COLEMAN: Much of the development of our new facilities that will treat many waste streams that are quite unique in the Department of Energy have only begun to be funded and put into place. Many of these facilities also have attached to them a technology development component or, I would call it, a technology adaptation component. To my knowledge, we have not participated in the standards area very much in the past; we should do more in the future. The transition that these programs have been going through in the last three years has caused people in our program to believe they did not have sufficient time nor resources for this participation. If we are going to adapt the standards that have been developed for the commercial sector for the Department's somewhat unique challenges, we are going to have to participate much more. I hope you will hear much more about that in future Conferences.

McGALLIAN: There is a program at present, called waste minimization, residue elimination, which partially addresses Dr. First's question. They are going into a design concept to eliminate residue and encourage waste minimization at Rocky Flats. That is going to require a large research effort into air treatment at Rocky Flats. In fact, I have been recently questioned about the waste minimization and waste residue project at Rocky Flats. Is it going to continue under the budget of the waste program or will it go under the environmental management? What do you see?

COLEMAN: I am not directly involved in this subject, but it is my understanding that at the present time there is consideration being given to the transfer of the Rocky Flats Plant from Defense Program to the Environmental Restoration and Waste Management Program. I am not familiar with all the details. My understanding is that the Rocky Flats Plant is not going to be put into operation again. The suitability of transferring it to our offices for the cleanup and disposal of the waste, including how we manage the residues, is clearly an open question. There is a great deal of work going on in that transition plan, as you perhaps are aware. I expect that sometime this Fall the transition is likely to take place.

McGALLIAN: The transition plan went to DOE Headquarters. My next question is, does the program for the Rocky Flats transition period fall under a Transition Program Department, and is that a separate department?

COLEMAN: It is a separate office that has been established under the Environmental Restoration and Waste Management Program called Facilities Transition. I am not sure how long the Rocky Flats Plant will stay in the transition group before it is split up between the cleanup program and our program in waste management. If you call me at Headquarters, I will try to get an answer for you. The estimate is that there may be, over the next decade, some 1,000 different facilities that will have to be transferred from Defense Programs to our program for cleanup and waste management.

RICE: Our work is governed by DOE-6430-1A, now becoming 1B, which has been in draft form for quite some time. It also refers to AG-1 and DOE NEF3-45 now in a revised form, but not currently in use in its present form. What I want to know is, when are these documents going to be put on the street for actual use?

COLEMAN: I can't answer that question. Maybe I will throw that one to Larry.

STIRLING: I am afraid I cannot help you either. I am not familiar with that particular one.

COLEMAN: Larry, is there a Standards Office in Environment that deals with this?

STIRLING: If you will see me afterwards I will make sure that somebody responses to your question, will get some guidance for you.

WEBER: Just as a point of information, I understand that the revised NEF standards are presently in the hands of Jim Leonard of Defense Programs.