THE CERTIFICATION OF TRANSURANIC WASTE

J. T. D'Ambrosia
Department of Energy
Washington, D.C.

B.C. Anderson, D. A. Alrich, B. W. Brown, J. F. Cook and V. S. Scown
EG&G Idaho, Inc.
Idaho Falls, Idaho

ABSTRACT

Transuranic waste results from the Department of Energy's (DOE) national defense and energy research and development activities. Transuranic (TRU) waste, as defined by DOE-Order 5820.2, is material declared as having no sigificant economic value, and contaminated with alpha-emitting radionuclides of atomic number greater than 92 and half-lives greater than 20 years, in concentrations greater than 100 nCi/g. Since 1970, DOE's policy has been to retrievably store TRU waste at six DOE sites awaiting disposal. The Waste Isolation Pilot Plant (WIPP), under construction in New Mexico, will be a Research and Development facility which will demonstrate the safe disposal of radioactive waste from defense activities. Prior to shipment to WIPP the waste must be certified as meeting the WIPP waste acceptance criteria.

This paper provides a review of DOE TRU waste certification activities at waste generating and waste storage sites. These activities include development and documentation of certification procedures, integration of waste generator activities, and the development of nondestructive examination equipment. Real-time radiography is being utilized to nondestructively identify waste contents, ultrasonics is used for verifying container integrity of waste packages, and passive and active neutron measurements are used to assay the waste package.

INTRODUCTION

As of December 31, 1982, approximately 72,000 cubic meters of defense transuranic (TRU) waste had been stored at six DOE sites. This waste consists mainly of discarded contaminated paper, protective clothing, glassware, and equipment. When TRU waste was originally segregated, the contamination limit was greater than 10 nCi/g. However, DOE concluded in 1982, that a more appropriate contamination limit would be 100 nCi/g. Therefore, an estimated 30-40% of the waste stored at these DOE sites may be actually low level waste (i.e., below 100 nCi/g). At the Idaho, Hanford, Los Alamos, and Savannah River sites, this packaged waste has been placed on asphalt pads, covered with protective sheets of plywood and canvas or plastic sheeting, and then with several feet of soil. This assures that the waste packages will not degrade, and will be retrievable for at least 20 years after being placed into storage. Due to the small volumes of waste at the other two sites, alternative storage methods are used. At Oak Ridge, the waste packages are stacked inside rooms constructed in the side of a hill, and at the Nevada Test Site, metal cargo containers are used for storage.

The Waste Isolation Pilot Plant (WIPP), now under construction near Carlsbad, New Mexico, is a research and development facility for demonstrating the safe disposal of radioactive waste. The disposal demonstrations at WIPP will include mostly contact handled ($\leq$200 mrem/hr at surface) TRU waste with a relatively small amount of remote handled (>200 mrem/hr <100 R/hr at surface) TRU waste also included. There is a planned demonstration period of five years, after which the experiments will be analyzed, and a decision made regarding leaving the waste in place at the WIPP.

a. Presenters.

DOE TRU Waste

The WIPP demonstrations will begin with the waste which is retrievably stored at the Idaho National Engineering Laboratory (INEL) outside of Idaho Falls, Idaho. This is the largest volume of packaged TRU waste and was specifically addressed in the WIPP Environmental Impact Statement. The main source of the waste stored at Idaho is the waste from the Rocky Flats Plant, in Golden, Colorado, but waste is also stored at the INEL from Battelle Columbus and Mound Laboratories in Ohio, Argonne National Laboratory (outside of Chicago), the Bettis Atomic Power Laboratory (outside of Pittsburgh), and waste generated on the INEL site. Waste stored and/or generated at the other DOE sites may also be included in the WIPP demonstrations, but this decision awaits completion of the appropriate National Environmental Policy Act (NEPA) process.

Acceptance criteria have been developed for waste to be received at the WIPP. These Waste Acceptance Criteria (WAC)[1] will help insure that transportation, above- and below-ground handling, disposal, and retrieval (within the first 15 years of operation, if necessary) can be safely accomplished. The focus of the WAC is on complete documentation of the waste container contents. For example, there are no free liquids allowed in a waste container for WIPP and all containers must have corrosion protection. To reduce the fire hazard in the waste storage area, the outside containers of all packages must be noncombustible. Tests showed there was no need to limit combustible content of containers, but for the ease of separation (since not all combustible waste should be emplaced in one area of the WIPP), all containers with greater than 25% combustible content will be color coded. There is also a limit on the amount of respirable fines allowed in any one waste package. Additional criteria exist which the waste must also meet in order to be acceptable to the WIPP. Like those mentioned above, these additional criteria are also associated with mine safety.

DOE Waste Certification Program

Each storage site and generator planning to send waste to WIPP is required to develop plans for activities and facilities and to certify that the waste meets the WIPP WAC. The DOE goal is to have all routinely generated TRU waste be certified upon generation by the end of 1985. This certified waste will be stored separately from the uncertified waste, and will then be available for transport to the WIPP when it becomes operational. All storage sites now have the capability to store certified waste separately from uncertified waste. Once waste is certified as acceptable to WIPP, it is placed into storage in a manner which will not change its certifiable status.

In order for newly generated waste to be certified, a series of steps must be completed. Each generator must develop certification and quality assurance plans. The certification plan will address the process by which the waste is to be certified. For example, a generator may propose that only a certain type of waste will go into a certain container, or all waste containers will be examined prior to being sealed, or any procedure which the generator chooses to properly segregate waste. The quality assurance plan must state the procedures which will insure that the certification plan will be followed correctly. It will therefore insure that a certain container of waste is actually certified to the WAC. Both plans are reviewed by the WIPP WAC Committee, which consists of representatives of the DOE and DOE contractors. These representatives include a health physicist, a quality assurance engineer, an environmental engineer, and a nuclear engineer. The committee reviews the submitted plan, and if it is acceptable, issues a preliminary acceptance to the generator, and the committee approved plan is provided to the State of New Mexico for state review. After state comments are resolved, the committee conducts an audit of the generator to assure that the procedures will be followed correctly. Once the audit is successfully completed, the generator can then certify that the TRU waste being produced is acceptable to WIPP. The certification plans from Mound Laboratory have been approved by the committee and have been sent to the State of New Mexico for comment. All the other sites have submitted drafts of their plans to the committee, and are working to resolve the committee's comments.

Waste which is newly generated can be fully characterized, since the generator simply needs to keep complete records and comply with the WAC. DOE has also developed plans to certify the waste which is already in storage. One of the ways of obtaining the information necessary to certify this waste is by careful review of generator records. Unfortunately, adequately detailed records are not always available. Therefore, in order to certify the stored waste without opening each waste container and sorting through the contents (a costly and dose-intensive activity), technology has been, or is being, developed within the DOE complex.

For example, equipment has been developed which will assay a container of waste to determine if the TRU content is greater than 100 nCi/g. (Any waste containing less than this amount of TRU contamination is designated low-level waste and will be disposed of accordingly. Waste with greater than this amount of TRU contamination is treated as TRU waste.) DOE has also adapted real-time radiography (RTR) scanning equipment (similar to that used in airports), so that a worker can examine the contents of a waste package without opening the container.

The purchase and installation of RTR equipment will occur at different times at the various sites. This will provide for equipment installation and operation at the first site (Idaho), before the order is placed for the equipment for the next site. Such phasing will allow the users to suggest changes in design, reducing the potential for duplication of effort, minimizing the funding required in any one year for TRU waste certification activities, and maximizing utilization of information gained by each new operator. Assay equipment will be installed at several of the largest generating sites, in addition to the storage sites, which will allow the generators to segregate low-level waste from TRU.

The DOE is constantly evaluating waste management plans in order to minimize the cost of treatment and disposal. In June 1983, the President submitted the Defense Waste Management Plan to Congress. This plan outlined technology development, processes, and facilities required to dispose of DOE's TRU waste, and suggested funding profiles. In the eight months since that plan was submitted, DOE has been working to reduce the funding needs by re-evaluating proposed processes, and examining less expensive alternatives that would provide acceptable environmental and worker protection.

One of the ways by which DOE is trying to reduce TRU waste related costs is by phasing equipment purchases (as noted above) which allows optimization of equipment based on operating experience. There are also extensive efforts underway to reduce the volume of the TRU waste produced. One of the most cost-effective volume reduction techniques is the proper segregation of low-level and TRU waste at the point of generation (before the waste is packaged). This requires that procedures be followed at the generating point such that waste which is most likely low level (i.e., generated in non-TRU contaminated work areas) are packaged separately from waste likely to be TRU (i.e., materials which have been removed from gloveboxes). TRU waste volumes can also be reduced by assigning the waste at the generating point so that waste which has the potential to be TRU can be determined to be either TRU or low-level waste. Other volume reduction techniques include shredding, compaction, and incineration. The cost-reduction efforts also include the phasing of facilities required to certify the TRU waste which is already stored.

The first demonstration of stored waste retrieval and certification will be conducted at the INEL. The Stored Waste Examination Pilot Plant (SWEPP) will be completed in 1985, with radioactive demonstrations beginning at the end of that year. This facility will provide for waste retrieval and examination, after which the waste which contains >100 nCi/g will either be certified as WIPP acceptable, or will require further processing. Should the waste coming out of SWEPP require further processing, the Processing Experimental Pilot Plant (PREPP) will be available for radioactive operations at Idaho in 1986. This facility will contain a shredder to reduce the volume of waste requiring disposal, as well as an incinerator (again for volume reduction), and a cementation process, which will immobilize the *volume-reduced* container contents. Waste which has been processed through PREPP is expected to be certifiable as acceptable for WIPP, and will be reexamined in SWEPP.

These facilities at Idaho will be the first of their kind, but because TRU waste is also stored at other DOE sites, similar facilities may also be required at these sites. For example, we expect to begin construction of a facility similar to SWEPP at Los Alamos National Laboratory in 1986, and at Hanford later in the 1980's. These facilities will be designed, constructed, and operated after the Idaho facilities, and will thus benefit from that experience. We anticipate that most of the contact-handled TRU waste being generated, as well as that already in storage, can be certified as suitable for emplacement in the WIPP through the activities outlined above.

The major objectives and activities of the DOE TRU certification program have been described. The remainder of this paper will discuss the specific nondestructive examination (NDE) equipment which will be used in SWEPP (and other certification facilities at other sites) to assure that stored waste can be certified.

Real-Time Radiography

RTR will be utilized in SWEPP to examine the contents of waste packages. One purpose of the examination is to obtain information required to certify the waste for acceptance at WIPP and another is to determine if the waste contents can be processed in PREPP. In support of certification for WIPP, the RTR will be used to determine if free liquids, significant quantities of particulate material, or pressurized containers exist in the waste. RTR will also be used to estimate the quantity of organic and combustible material in the package. In determining if the waste package can be processed, it is necessary to estimate the shreddability of contents, and to verify that it does not contain (1) materials such as lead and mercury which could affect the operation of the PREPP offgas system, or (2) materials that would be explosive during incineration.

A real-time radiography system was designed and installed to determine if the desired information could be obtained on a reliable basis. The real-time radiography system includes the following major subsystems:

1. Shielded enclosure
2. Mechanical manipulator
3. 420 KVp constant-potential x-ray head
4. Imaging system
5. Videoprocessor, recorder, and monitors.

The shielded enclosure is 10 ft wide by 18 ft long by 7 ft high, with a 7- x 7-ft shielded door at one end. It consists of structural steel framework, covered with lead paneling. The lead paneling over the entire structure is 3/4 in. thick, except in the primary beam area, where an additional 1 in. of lead was added to reduce the radiation level to less than 2 mrem/hr at the exterior of the enclosure. The imaging system and the x-ray source are mounted on opposite internal walls of the enclosure.

The mechanical manipulator system consists of two segments. The first segment provides the vertical translation of the x-ray source and the imaging system. They can be electrically synchronized to travel in line with each other or at an offset to enable angular viewing through the waste package. The speed can be adjusted from 0 to 8 fpm. The second segment is the cart which transports the drums or boxes into the shielded enclosure. Boxes are examined as the cart is translated laterally inside the enclosure. A housing with three turntables is mounted on the cart for rotating the drum during examination. The cart and turntable assembly will support a 10,000-lb box or three drums weighing 1,000-lb each. The cart is mounted on rails, and travel is adjustable from 0 to 30 fpm. The turntable will rotate at a rate of 0 to 5 rpm.

The 420 KVp constant-potential x-ray head is a standard, commercially available unit that has an output dose rate of 11,000 R/min at 200 mm. The voltage of the unit can be varied from 90 to 420 KVp. The current can be varied from 0 to 10 mA at the maximum voltage.

The imaging system consists of a fluoroscopic screen and a low-light level Isocon CCTV camera. The camera is mounted inside a shielded light tight enclosure to protect the lens and electronic components from radiation damage. The camera has five lenses in a turret arrangement, which permits remote selection of image size, from 0.5X to 2X magnification. The lenses point at a first-surface mirror, mounted at a 45° angle, which in turn views the fluoroscopic screen. The fluoroscopic screen is 32 in. high by 24 in. wide and is covered with gadolinium oxysulfide coating approximately 12 mils thick.

The output from the imaging system is supplied to two CCTV monitors at the operator's station. One monitor always presents the images directly from the camera. The operator can use the second monitor to view a processed image. The processing can consist of videotaping, adding printed data on the videotape via a character generator, or enhancing the image in a digital filter and video frame averaging processor. Image enhancement using the digital video processor is best performed on still images.

The system has been used to examine mockups as well as actual waste packages to determine how effective the system will be during operation in SWEPP. Approximately 5 min. is required to examine a drum and complete a summary data sheet. The examination of a box requires approximately 15 min.

Examinations performed to date indicate the system will identify the waste package contents adequately to permit certification to the WIPP and PREPP waste acceptance criteria. During the next year, waste packages will be selected from the stored waste, radiographically examined, and then opened and the contents visually examined. The RTR and visual examination results will be compared to verify that this NDE process is effective in certifying the waste. This sampling program provides an informational feedback to the RTR Operator on the accuracy of their interpretation skills. During the campaign, a sample of the waste packages certified for shipment to WIPP, in SWEPP, will be opened in PREPP to assure that the quality of the NDE examination process is maintained.

Container Integrity

The second NDE system being developed is a container integrity system to ensure that the container has not deteriorated during storage at the INEL. The wall thickness is measured and abnormalities recorded using automated ultrasonic thickness measurements with on-line data processing.

The container integrity system includes the following major subsystems:

1. Drum tilt/rotation stand
2. Drum cleaning assemblies
3. Ultrasonic thickness gauge and transducers
4. Data processing equipment.

The drum/tilt/rotation stand provides the structural support for the drum and the fixturing associated with obtaining the measurements. The drum is tilted to an inclined position to maintain good contact with the rotational drive rollers and transducers. A reservoir catch basin is incorporated into the base of the stand to collect the water used as a couplant for obtaining the ultrasonic measurements. Nylon brush assemblies are pivoted into position to remove any dirt or loose paint from the areas where measurements are to be obtained. A portable ventilation HEPA filter system is used as a vacuum cleaner to collect the majority of the debris removed during the brushing operation, even though the external surfaces of the waste package are radiologically clean.

A test program was performed to define the optimum equipment and techniques, and to develop specification criteria for the ultrasonic measuring and data recording equipment. The system now in operation includes an eight-channel multiplexed ultrasonic digital thickness gauge, bubbler-type search unit holders, both analog and digital recording, and digital data processing.

The eight search units are mounted on the tilt stand to measure preselected locations on the drum. The search units are spring-loaded to maintain good contact with the drum surface while it is rotated. The couplant flow system picks up water from the reservoir in the bottom of the stand, processes it through a filter to remove particulates, and then distributes it to the search units. The couplant then flows down the side of the drum back to the reservoir.

Each search unit includes an ultrasonic transducer operating at 10 MHz to measure the container wall thickness. A thickness reading is obtained at 0.040-in. increments of drum travel for each of the eight search units. The data are fed to a strip chart recorder and to a microcomputer. The microcomputer is programmed to calculate the average thickness, standard deviation, and the minimum thickness reading for each inch of drum travel. At the end of one rotation a data summary is presented which is used to determine if the drum meets the DOT criteria[2] stated for a new drum. The summary includes the distribution of minimum thickness readings, average thickness and standard deviation for each of the eight tracks. The accept/reject criteria are currently being developed. If the container is rejected by this examination, it will be overpacked in a DOT-approved container for shipment to WIPP.

Assay

A third type of NDE equipment is being developed for certifying stored waste in SWEPP is Assay Equipment. Los Alamos National Laboratory, the developer has reported on this equipment elsewhere.[3,4] The SWEPP assay system will consist of a box/bin counter and a drum counter to accomodate the projected throughput of the other NDE systems in SWEPP. The assay consists of passive and active neutron measurements to determine the total TRU content, thermal output, and fissile material content of the waste package. The prototype drum counter is currently operating at Oak Ridge National Laboratory and the prototype box/bin counter is operating at the Rocky Flats Plant near Denver, Colorado. The two counters utilized in SWEPP will be built by LANL and will be similiar to these prototype systems.

CONCLUSION

The Department of Energy (DOE) is developing certification plans and procedures to assure that TRU waste is acceptable for receipt at WIPP. In doing so, we are also demonstrating new technology in waste characterization, and are developing new equipment for nondestructive examination of waste packages.

Real-time radiography is being developed to support certification of waste packages by identifying the contents and to permit safe processing in PREPP if the waste package cannot be certified for shipment to WIPP. An ultrasonic system is being developed to verify that the container has not deteriorated during storage at the INEL. This NDE technology will be disseminated to other DOE sites to minimize the cost for certifying TRU waste.

REFERENCES

1. WIPP Technical Support Contractor, "TRU Waste Acceptance Criteria for The Waste Isolation Pilot Plant" WIPP-DOE-069 Revision 1, Westinghouse Electric Corporation, September 1981.

2. Code of Federal Regulations 49 CFR 173, 398(b).

3. Nuclear and Chemical Waste Management "Measurement of Transuranic Content in Wastes" Vol. 4, pp. 11-17, 1983.

4. Los Alamos National Laboratory "Test and Evaluation of a High Sensitivity Assay System for Bulk Transuranic Waste" LA-UR-83-2084.