OPERATIONAL PROCEDURES FOR RECEIVING, PACKAGING, EMPLACING, AND RETRIEVING HIGH-LEVEL AND TRANSURANIC WASTE IN A GEOLOGIC REPOSITORY IN TUFF*

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ABSTRACT

The Nevada Nuclear Waste Storage Investigations Project, directed by the Nevada Operations Office of the Department of Energy, is currently developing conceptual designs for a commercial nuclear waste repository. In this paper, the preliminary repository operating plans are identified and the proposed repository waste inventory is discussed. The receipt rates for truck and rail car shipments of waste are determined, as are the required repository waste emplacement rates.

INTRODUCTION

Sandia National Laboratories, under the direction of the Department of Energy, and in cooperation with Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and the United States Geological Survey is engaged in the conceptual design of a repository for commercially generated radioactive waste as part of the Nevada Nuclear Waste Storage Investigations Project. This repository design is being developed through the Civilian Radioactive Waste Management (CRWM) Program as directed by the Nuclear Waste Policy Act of 1982. If constructed, this repository would be located on federally owned land at Yucca Mountain, Nye County, Nevada (Fig. 1).

An initial set of repository operating procedures has been prepared[1] and the expected annual exposure of workers to penetrating radiation, using these procedures, has been determined.[2] Operating procedures are currently being revised to reduce the expected operator dose during the waste receiving and emplacement operations. These revised procedures will be incorporated in a subsequent edition of the operating procedures document.

The limited time available allows only the presentation of the design parameters now being used to determine repository operational requirements. This paper describes:

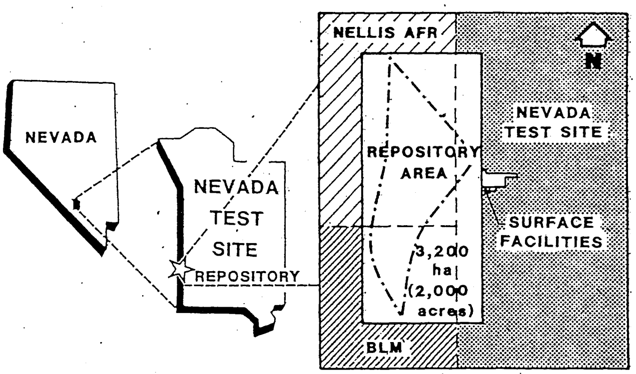

Fig. 1. General location of the candidate area and the site.

- the annual waste receipts now being used as the basis for conceptual design of the surface waste receiving facilities,
- the waste shipment packaging that should be available for shipping the waste materials from the waste generators to the repository site,

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- the basis for planning for the receipt of waste transport by truck and rail cars,
- the planned reconfiguration and packaging of the wastes before it is transferred to the underground repository area, and
- the emplacement of the waste in the geologic formation.

The repository surface facility operations (receiving, handling and packaging, and storage of spent fuel and high-level waste) are depicted in Fig. 2. The underground repository operations (transfer of the waste disposal package from surface storage to the disposal horizon and emplacement) are shown in Fig. 3.

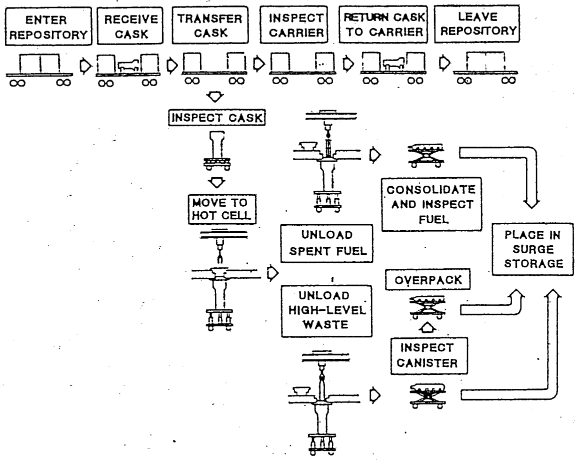

Fig. 2. Receiving, handling and packaging, and storage of spent fuel and high-level waste.

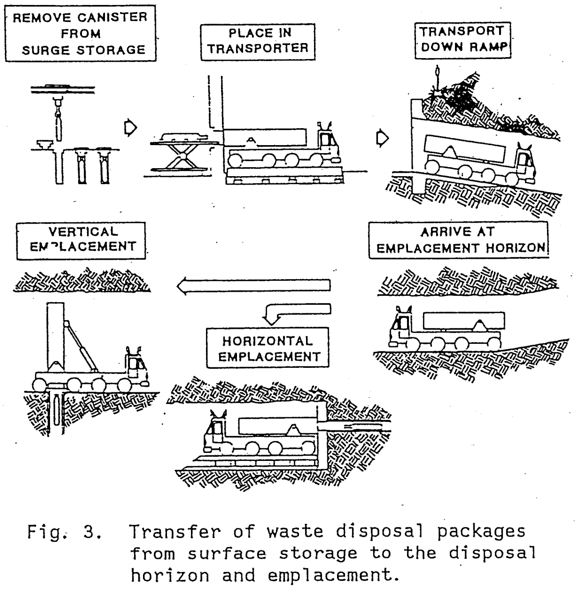

Fig. 3. Transfer of waste disposal packages from surface storage to the disposal horizon and emplacement.

ANNUAL WASTE RECEIPTS

A description of the waste and estimates of waste shipping rates and the cumulative waste quantities that could be shipped to a repository are contained in a forthcoming DOE guidance document entitled "Generic Requirements For a Mined Geologic Disposal System" (GR). The information relating to waste receipts characteristics contained in this paper is consistent with the January 18, 1984 draft of this document.

The repository conceptual design will be based on three categories of waste. They are

- Spent Fuel Assemblies (SFA's),
- High-Level Waste (HLW) from spent fuel reprocessing, and
- Commerical Transuranic Waste (TRU).

The SFA's are subdivided into two categories: fuel assemblies from pressurized water reactors (PWR) and fuel assemblies from boiling water reactors (BWR). The HLW is limited to that now stored at the inactive West Valley, New York, fuel reprocessing plant. The TRU waste is generated during commercial fuel fabrication, reactor operations, and facility decommissioning and decontamination activities. Table I lists these commercial wastes and their assumed annual receipt rates.

TABLE I
Expected Annual Waste Receipt Rates

	Waste Type	Annual Receipts
SFA's:	PWR Assemblies	2,700
	BWR Assemblies	3,900
HLW:	Canisters	300
TRU:	55-gallon drums	400

For normal operations, the annual receipts rates listed in Table I will be used in the conceptual design of the repository facilities. However, it is recognized that other waste categories may also be disposed of at a commercial HLW repository. Such wastes might include commercial HLW and TRU waste from future reprocessing facilities, TRU waste from future commerical mixed oxide (MOX) fuel fabrication plants, and defense HLW from the planned Defense Waste Production Facility (DWPF) or a similar facility. Therefore, the repository will be designed to accommodate the wastes specified in the GR, but will not preclude the future addition of other waste categories.

It is worth noting that the repository is not expected to accept low-level wastes suitable for disposal at commercial surface disposal sites. Examples include BWR and PWR reactor control rods, BWR fuel channels, and non-fuel bearing components of BWR and PWR fuel assemblies. Intact fuel assemblies and fuel rods from at-reactor fuel consolidation operations will be accepted.

Fluctuations in the annual receipt rate of spent fuel (SF) and other wastes will be accommodated by designing the facilties to receive and emplace 150% of the expected waste receipts in Table I. Present planning calls for the repository to operate 4,000 hours per year (two 8-hour shifts per day, 5 days per week, 50 weeks per year). The additional requirements for peak yearly operations (150% of normal operations) would necessitate, at most, an additional 2,000 operating hours (one additional 8-hour shift, 5 days per week, 50 weeks per year).

WASTE SHIPMENT PACKAGING

The Transportation Technology Center (TTC) at Sandia National Laboratories is directing a conceptual design program at GA Technologies, Inc. to define generic shipping casks for HLW. Additionally, TTC is engaged in the design of packaging for use during the tranportation of TRU wastes generated in defense programs. The TRU transportation packaging is called a TRUPACT. Descriptions of both the casks and the TRUPACT are contained in the operational procedures document.[1] TTC's conceptual cask designs and TRUPACT design will be used in the conceptual design of repository facilities. Table II lists the maximum numbers of waste packages that can be accommodated in each category of waste transportation cask and the TRUPACT. The SF identified in the GR has a higher burnup, hence higher radiation levels, than that used by GA Technologies in cask conceptual design; rail cask capacities for SFA's listed in Table II may, therefore, be decreased in the future.

TABLE II

Assumed Capacities of Waste Shipment Packaging

Waste Type		Transportation System: Truck	Rail-Car
SFA's:	PWR Assemblies	1	12
	BWR Assemblies	2	32
HLW:	Canisters	1	5
TRU:	55-gallon drums	36*	72*

* The TRUPACT has a capacity of 36 drums. It is assumed that there will be 1 TRUPACT per truck shipment and 2 TRUPACTs per rail-car shipment.

PLANNING BASIS FOR RECEIPT OF WASTE SHIPMENTS

The GR document contains planning guidance relative to the expected division between truck and rail waste shipments. A minimum of 70% of all waste shipments may be by truck transport, and a maximum of 80% of all waste shipments may be by rail transport. The expected annual number of truck and rail waste shipments can be estimated on the basis of this information and the information contained in Tables I and II. These annual receipt rates were determined for the maximum number of truck shipments first, and then for the maximum number of rail shipments. For planning purposes, a shipment is defined as the waste delivered by a single truck or rail car. The annual number of shipments expected is listed for each transportation mode in Table III.

Assuming the repository receives waste 250 days per year, an average of 14.5 trucks and rail cars loaded with waste would be received each working day in the "truck maximum" case; an average of 5.25 trucks and rail cars loaded with waste would be received each working day for the "rail maximum" case. The total in-facility time required to receive and return a truck HLW shipping cask has been estimated to be 850 minutes by Sandia National Laboratories[2] and 974 minutes by the Hanford Engineering Development Laboratory.[3] With one exception, all cask receiving and return operations are similar and would require similar amounts of time. An exception, the time to unload multiple waste items (SFA's or HLW canisters), is estimated to be 10 minutes per additional item.

TABLE III

Expected Annual Number of Truck and Rail Car Shipments

Waste Type		Expected Number of Shipments: 70% Truck/30% Rail	20% Truck/80% Rail
SFA's:	PWR	1896/67	540/180
	BWR	1374/36	382/98
HLW		210/18	60/48
TRU		9/2	2/5
TOTAL TRUCK/RAIL SHIPMENTS		3489/123	984/331

The conceptual design of surface waste receiving facilities and their estimated costs will be directly affected by the system capacity chosen. It is currently believed that this problem can be addressed best by using a modular receiving facility design and a ramp access to the underground repository area.

RECONFIGURATION AND PACKAGING OF WASTE

Repository consolidation of SF, before the waste packages are transferred to the underground repository area, is currently under consideration. The SF consolidation operation consists of removing the individual fuel rods from the SFA's and placing the rods in a close packed array in the waste disposal package, Fig. 4. Fuel rods from 6 PWR SFA's or 18 BWR SFA's will be placed in a single waste disposal package. The non-fuel-bearing assembly components (all component hardware left after the fuel rods have been removed) will be compacted and packaged separately. The component hardware will be emplaced in the repository in the same manner as TRU waste.

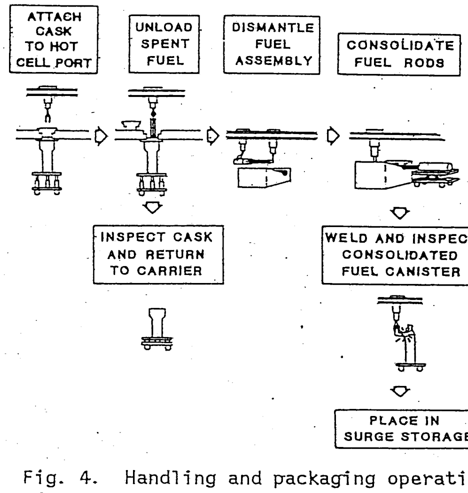

Fig. 4. Handling and packaging operations for spent fuel.

HLW and TRU waste will be emplaced "as received" provided the waste packages meet repository acceptance criteria. If any of these waste disposal packages have been damaged and do not meet the acceptance criteria, they will be repaired or overpacked before being transferred to the underground repository area, Fig. 5. The expected annual emplacement rate of waste packages is listed in Table IV.

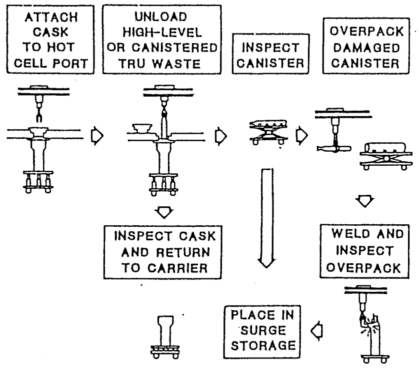

Fig. 5. Handling and packaging operations for high-level waste and canistered TRU waste.

TABLE IV

Expected Annual Emplacement Rate for Waste Packages

Waste Type	Number of Disposal Packages: Canisters	Number of Disposal Packages: 55-Gallon Drums
Consolidated PWR Fuel Rods	450	-
Consolidated BWR Fuel Rods	217	-
Fuel Assembly Hardware	110	-
HLW	300	-
TRU	-	400
TOTAL	1,077	400

If the repository operates 250 days per year, an average of 4.3 canisters of waste and 1.6, 55-gallon drums must be transferred to the underground repository area each working day.

WASTE EMPLACEMENT

Two waste emplacement methods are currently being developed at Sandia National Laboratories for consolidated SF and HLW. Emplacement of a single waste package in a vertical borehole located in the drift floor, Fig. 6, is the repository's reference emplacement method. Emplacement of multiple waste packages in a horizontal borehole located in the drift wall, Fig. 7, is the alternate emplacement method. The operations required to emplace wastes by each of these methods are discussed in the operational procedures document[1] and the expected worker radiation exposures are discussed in the worker exposure document.[2] At this time, conceptual designs of facilities and equipment are being prepared for both concepts. TRU waste and repository-generated nuclear wastes will be emplaced in underground rooms. Conceptual designs of remotely controlled equipment to emplace this waste are being developed.

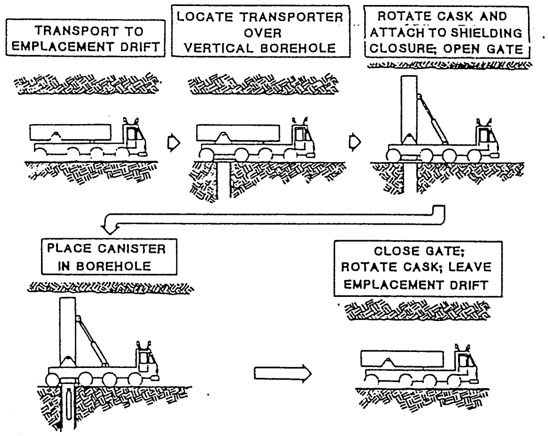

Fig. 6. Emplacement of waste in vertical boreholes.

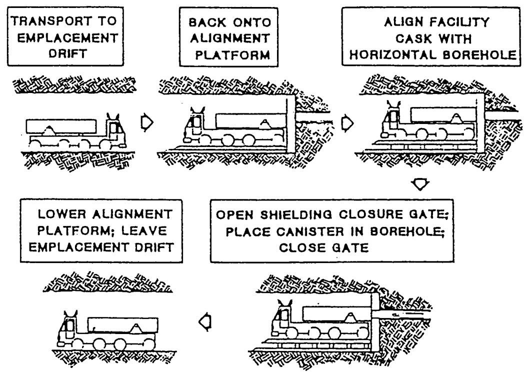

Fig. 7. Emplacement of waste in horizontal boreholes.

CONCLUSION

Sandia National Laboratories has begun conceptual design of repository surface waste receiving facilities and underground disposal facilities as part of the Nevada Nuclear Waste Storage Investigations Project. Preliminary repository operating plans have been developed, and the expected repository nuclear waste inventory has been identified. The surface waste receiving facilities and the repository underground area conceptual design will be developed based, in part, on this information.

REFERENCES

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