TMI ABNORMAL WASTES DISPOSAL OPTIONS[a]

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ABSTRACT

A substantial quantity of high beta-gamma/high-TRU contaminated wastes are expected from cleanup activities of Unit 2 of the Three Mile Island Nuclear Power Station. Those wastes are not disposable because of present regulatory constraints. Therefore, they must be stored temporarily. This paper discusses three options for storage of those wastes at the Idaho National Engineering Laboratory: (a) storage in temporary storage casks, (b) underground storage in vaults, and (c) storage in silos at a hot shop. Each option is analyzed and evaluated. Also included is a discussion of future disposal strategies, which might be pursued when a suitable federal or commercial repository is built.

INTRODUCTION

Cleanup activities of Unit 2 of the Three Mile Island (TMI) Nuclear Power Station may result in substantial quantities of high beta-gamma/high-TRU contaminated filters, sludges, ion-exchange resins, and equipment. Since no repository exists for wastes of that type, storage is projected until a final disposal facility is constructed and made operational. The Nuclear Regulatory Commission (NRC) and Department of Energy (DOE) have agreed that TMI should not become a long-term disposal facility for wastes from the accident.[1,2] As a result, receipt and interim storage of high beta-gamma/high-TRU contaminated wastes from TMI is currently planned at the Idaho National Engineering Laboratory (INEL). In addition, the wastes will be reviewed periodically for potential research value. This paper discusses options for both temporary storage and final disposal of the TMI abnormal wastes. Temporary storage options include outdoor storage in concrete casks, underground storage in steel vaults, and indoor storage in lead-lined steel silos. The storage options may have value to the industry if faced with similar storage problems in the future. Final disposal options include interment at a federal repository, use of an engineered TRU-waste facility, and use of a commercial disposal facility employing greater-confinement technologies. Final disposal will not be at INEL.

ABNORMAL WASTES

Currently inventoried abnormal wastes at TMI are estimated at about 930 ft^3; the wastes include plant cartridge filters, sludges, organic ion-exchange resins, miscellaneous contaminated equipment, and Submerged Demineralizer System (SDS) cartridge- and sand-filter assemblies. For this paper, it is assumed that those wastes are shipped to INEL in two hundred 30-gallon drums and nine SDS assemblies. When those wastes are characterized in more detail, some wastes may prove acceptable for disposal at a commercial disposal facility. Because total volumes and types of wastes expected from the TMI cleanup are uncertain, storage and disposal methods are flexible enough to handle significant changes in volume.

STORAGE AND DISPOSAL SEQUENCE

In the United States, disposal sites for high-TRU wastes do not exist presently, although such facilities are under development. To provide for final disposal of TMI abnormal wastes, a disposal sequence was developed that allows interim storage of the wastes until final disposal sites are available. Research on some of those wastes also may occur depending on developments in waste management practices. Figure 1 illustrates the sequence.

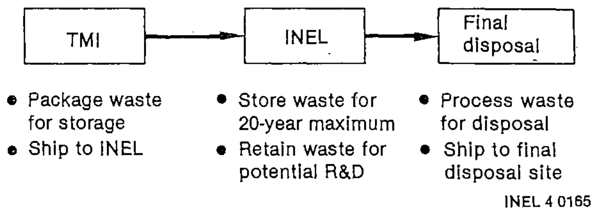

Fig. 1. Disposal sequence developed for TMI abnormal wastes.

The first step involves packaging the wastes (according to criteria formulated by INEL) and transporting them to INEL for interim storage. The second step provides suitable storage at INEL that will permit retrieving or sampling wastes for research. And the last step is retrieving the wastes and repackaging them into forms acceptable to the yet-to-be-built federal repository. At the end of the interim storage period, INEL could process the wastes to final disposal form(s), or coordinate the processing with other DOE or commercial facilities. Then INEL would coordinate shipment to the final disposal site.

INEL STORAGE OPTIONS

Three options for interim storage at INEL are: (a) Option 1--outdoor storage in temporary storage casks, (b) Option 2--underground storage in vaults, and (c) Option 3--storage in the EPICOR-II silos in the Test Area North (TAN) Building-607 Hot Shop. Since each option has inherent advantages, selection of the best option is dependant upon a multitude of fiscal, technical, institutional, and environmental considerations. Those considerations, however, may not have equal applicability to another facility. Therefore, any of the three options discussed here could be included in an analysis.

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Option 1 involves placing the packaged TMI abnormal wastes in concrete temporary storage casks (Fig. 2) and storing the casks outdoors at TAN. Eight 30-gallon drums or three SDS filters would be placed in each cask. Twenty-eight casks (25 for sludges and three for filters) would be sufficient to store the wastes currently identified.

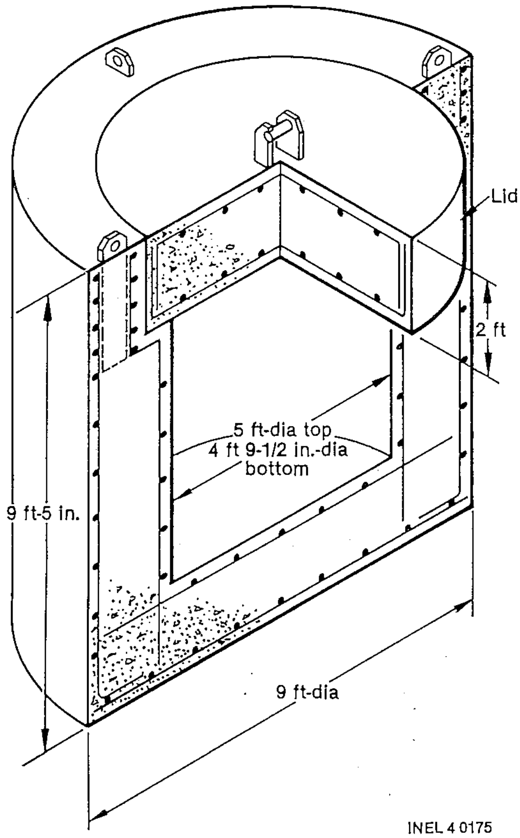

Fig. 2. Concrete temporary storage cask for interim storage of TMI abnormal wastes at INEL.

There are several advantages of Option 1. The option is flexible enough that any volume of abnormal wastes could be accommodated simply by varying the number of temporary storage casks. Another advantage is that the temporary storage cask can accept several sizes of waste packages. Long-term storage of TMI abnormal wastes by this method would not impact other INEL programs. Similar storage casks were built in the late 1950s and have remained outdoors since, with no deterioration. One disadvantage is that Option 1 requires more handling of the wastes, with the attendant risks.

Option 2 involves placing TMI abnormal wastes in underground storage vaults similar to those in the Intermediate Level Transuranic Storage Facility of the Radioactive Waste Management Complex at INEL. Figure 3 shows a typical vault (24-inch diameter by 15-foot length) presently in use for storage of high beta-gamma/high-TRU contaminated wastes produced by other programs. Fifty vaults of that type would be used for storage of the 30-gallon drums containing TMI abnormal wastes. SDS filters would require five 30-inch-diameter vaults of a similar design. A 30-inch vault also could be used for 55-gallon drums.

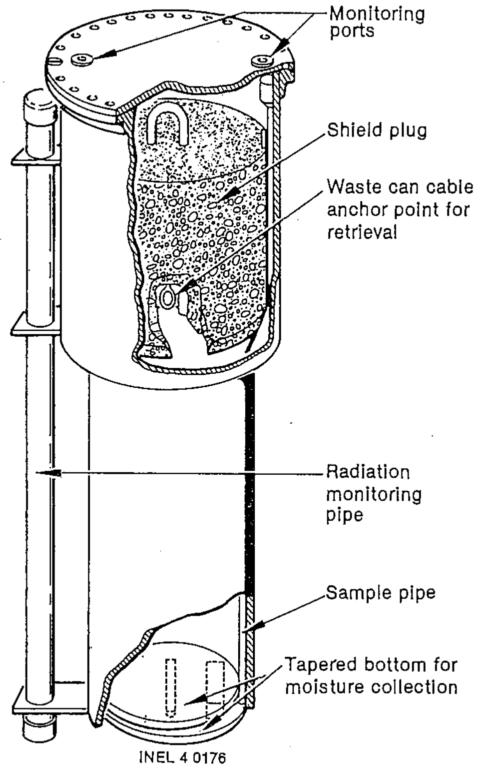

Fig. 3. Typical 24-inch diameter intermediate-level TRU-waste vault at INEL.

Option 2a is identical with Option 2 except that a shielded transfer cask is provided to transfer high-radiation waste packages into the vault.

Option 2 has several advantages over other options. The first is that similar wastes are stored routinely at INEL and the technology is well developed. Much of the required equipment, procedures, and systems for monitoring the wastes already exist. Personnel experienced in waste handling and equipment operation also are available. Secondly, this option is flexible in that the number of vaults needed is proportional to the total volume of abnormal wastes. However, one disadvantage is that it takes longer to construct the vaults for Option 2 than the temporary storage casks (Option 1). Another disadvantage of Option 2 is that a new transfer cask would be needed for receiving abnormal wastes with contact radiation levels greater than 100 R/h.

Option 3 involves placing TMI abnormal wastes in one of the two storage silos constructed for the EPICOR-II Program in the TAN-607 Hot Shop. Figure 4 illustrates a silo, filled with EPICOR-II liners. A storage silo could hold as many as 252 of the 30-gallon drums and 18 SDS filters, provided it is equipped with special racks. The drums would be stacked in four tiers and the filters in two tiers. That means the numbers and types of abnormal waste containers must be determined before the silo racks are designed.

There are several advantages to Option 3. The first advantage is that the silo exists; therefore, construction costs would be minimal and startup time for receipt of abnormal wastes from TMI would be shortened significantly. Procedures for unloading transportation casks and manipulating the silo are in existence; consequently, modifications thereof would be minimal. All operations would take place in the containment of the Hot Shop; that would reduce environmental risk in case of an accident. However, there are disadvantages, too. For example, programs presently using the Hot Shop facility, as well as those that may use the facility in the future, could create scheduling conflicts adversely affecting receipt and storage of abnormal wastes. Similarly, receipt and storage of abnormal wastes could impact adversely other programs. Also, the volume of abnormal wastes that can be stored in a silo is finite, limited by the space of that silo. If abnormal wastes at TMI significantly exceed the amounts estimated, another storage strategy would have to be involved.

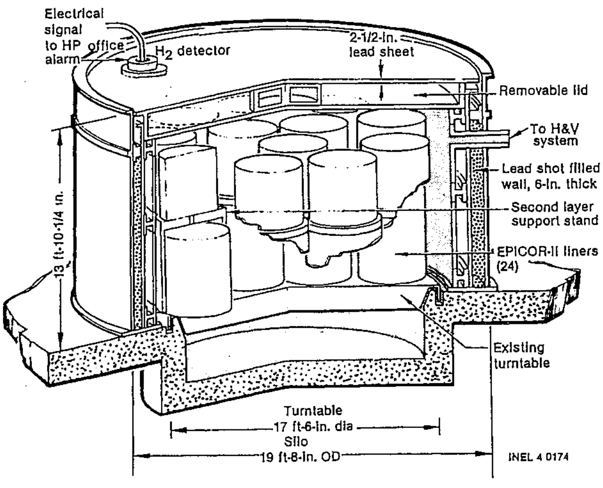

Fig. 4. Representation of the storage silo for EPICOR-II liners in the TAN-607 Hot Shop at INEL.

ANALYSIS OF INEL STORAGE OPTIONS

Table I shows a comparison of the INEL storage options. The costs listed are based upon "rough-order-of-magnitude" estimates to provide interim storage, place wastes in storage, and monitor wastes for 20 years. Not included are costs for retrieval, final processing, transportation, and final disposal. Table II is a decision analysis of the above comparison using Kepner-Tregoe methods.[3] For INEL, the option that had the highest weighted score was the use of concrete temporary storage casks (Option 1). Therefore, it is concluded that temporary storage casks provide the best method of interim storage.

FINAL DISPOSAL OPTIONS

The largest uncertainty in the disposition of TMI abnormal wastes is the method and place of final disposal. Since existing waste sites cannot accept TRU-contaminated wastes for final disposition, no method for disposal of abnormal wastes presently exists. However, planning for suitable repositories is being done by various agencies. Unfortunately, a suitable facility for TMI abnormal wastes will not be available until late next decade, at the earliest.

Presently, the most promising location for disposal of TMI abnormal wastes is the federal high-level waste (HLW) repository being developed by the federal government under the Nuclear Waste Policy Act of 1982.[4] NRC has been developing regulations for such a repository for several years. Proposed rules (10 CFR 60 issued in 1981) discuss placement of TRU-contaminated wastes in a repository.[5] That draft allows placement of TRU-waste packages in the HLW repository after NRC review.

If the wastes were disposed in a federal HLW repository, they would need processing into an acceptable final wasteform. The wasteform that has been most acceptable internationally for HLW is glass. Besides glass, DOE has been studying other final wasteforms, such as Synroc, Iron-Enriched Basalt, and special cement formulations. Presently, it appears that TMI abnormal wastes could be converted to glass, poured into a metal canister, and placed in an overpack similar to the final wasteform and packaging proposed for HLW.

Criteria for acceptable final wasteforms have been developed for the Waste Isolation Pilot Plant (WIPP).[6] Those criteria have been used as a guideline for formulating criteria for a special transuranic-waste repository (STWR). The later criteria require wastes be immobilized and placed in 24-inch-OD by 10-foot-high packages. Current requirements limit package radiation to 100 R/h; but revisions are anticipated which will allow a peak radiation field of 1000 R/h for a specific package, if all packages average 100 R/h.

Most TMI abnormal waste is sludge (containing significant quantities of fines), which probably will require immobilization to meet criteria of an STWR. Immobilization could be performed by (a) commercial solidification vendors, (b) by other DOE contractors at future immobilization facilities, or (c) by INEL using processes yet to be developed at INEL to treat TMI wastes. Any initial preparation of wastes for immobilization could vary according to capabilities of the facility, but final immobilization could be by solidifying with cement in 55-gallon drums. Present NRC regulations only apply to near-surface disposal at depths less than 30 meters. An STWR would allow disposal at greater depths, but new regulations would be required before it could be constructed.

Disposal at intermediate depth (as opposed to shallow-land or repository disposal) could involve two alternatives. The first is use of a greater confinement facility for disposal. Tests are being performed at the Nevada Test Site on disposal of wastes at depths of 45 to 100 feet below the surface. A disposal facility based on a similar design could be developed for commercial wastes. Immobilization could be required, depending on (a) regulations developed for such a facility, and (b) development of the detailed characterization of TMI wastes.

Another intermediate-depth alternative would involve disposal at NRC licensed disposal sites for commercial low-level wastes. NRC regulations for classification of wastes disposed at those sites are in 10 CFR 61.[7] Requirements are included for disposal of Class A through C (low-level) wastes. However, allowance is made for special disposal of wastes that have radioactivity concentrations above Class C, if special wasteforms and disposal methods are involved. A combination of immobilization, use of a high integrity container, and burial below the trench depth usually used for low-level waste disposal might meet the special consideration requirements.

RESULTS AND CONCLUSIONS

Results of the study indicate that the optimum method for storing TMI abnormal wastes at INEL is temporary storage casks. Similar studies could be conducted by utilities having similar abnormal wastes concerns, with different results based on site

TABLE I.
Comparison of Three Storage Options for TMI Abnormal Wastes at INEL

Description	Option 1 Temporary Storage Casks	Option 2 Vault with Free-Air Transfer	Option 2a Vault with Transfer Cask	Option 3 TAN-607 Silo Storage
Cost (millions of 1983 dollars)	1.6	1.1	1.6	6.0
Flexibility for waste-volume changes	Excellent	Excellent[a]	Excellent[a]	Low
Flexibility for various waste containers	Excellent	Good	Good	Low
Maximum radiation of packages (R/h)	2500	100	2500	2500
Interference with non-TMI programs	Some	Some	Some	High
Safety/environmental risks	Low[b]	Low[b]	Low[b]	Low
Operational history of disposal enclosure (years)	20	8	8	2
Experience in similar waste storage operations (years)	2	8	8	2

a. But requires longer lead-time than Option 1.

b. Outdoor storage of wastes.

TABLE II.
Decision Analysis of Storage Options for TMI Abnormal Wastes at INEL

MUSTS

Factor	Options 1	2	2a	3
Store projected waste volume	OK	OK	OK	OK
Handle 30-gallon drums and SDS liners	OK	OK	OK	OK
Store waste for 20 years	OK	OK	OK	OK

WANTS

Factor	Weight	Option 1 Score	Option 1 Weighted Score	Option 2 Score	Option 2 Weighted Score	Option 2a Score	Option 2a Weighted Score	Option 3 Score	Option 3 Weighted Score
1. Cost	10	9	90	10	100	9	90	1	10
2. Flexibility for waste-volume changes	8	10	80	9	72	9	72	1	8
3. Flexibility for various waste containers	8	10	80	8	64	8	64	1	8
4. Maximum radiation of packages	8	10	80	1	8	10	80	10	80
5. Interference with non-TMI programs	4	10	40	8	32	8	32	2	8
6. Safety/environmental risks	5	6	30	6	30	6	30	10	50
7. Operational history of disposal enclosure	7	10	70	4	28	4	28	1	7
8. Experience in similar waste storage operations	7	2	14	10	70	10	70	2	14
Total			484		404		466		185

specific factors. The three options, as well as methods used in analysis of options, are included as strategies useful to utilities in managing storage and disposal of similar types and quantities of abnormal wastes, should they occur.

Because of congressional action, a federal repository is being developed for high-level wastes. However, no facility is being developed for either commercial transuranic waste or greater confinement of those wasteforms. Therefore, final disposal remains an open issue.

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