HANFORD SITE TRANSURANIC WASTE CONTAINER INTEGRITY

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ABSTRACT

The transuranic waste containers stored in the retrievable storage units at the Hanford Site are described along with a description of their environment. The containers are of various types, predominantly steel 0.21-m^3 (55-gal) drums and boxes of many different sizes and materials. The storage environment is direct soil burial and storage in atmospheric conditions under plastic tarps with earth on top of the tarps. Available data from several transuranic waste storage sites are summarized and degradation rates are projected for containers in storage at the Hanford Site.

INTRODUCTION

The Hanford Site is one of 14 U.S. Department of Energy (DOE) sites located throughout the U.S. that generate and/or store radioactive transuranic (TRU) waste from national defense programs. This waste is buried in trenches of several different designs or configurations and is stored in aboveground interim-storage areas.

The disposal of TRU waste stored at the Hanford Site at the Waste Isolation Pilot Plant (WIPP) is required by DOE Order 5820.2A (1), and the Hanford Site Defense Waste Final Environmental Impact Statement Record of Decision (2). Disposal will consist of retrieving the waste and repackaging and treating, as necessary, in the Waste Receiving and Processing (WRAP) Facility to certify for shipment to the WIPP.

A program for characterizing the stored contact-handled TRU waste before the initiation of full-scale retrieval is described in Ref. 3. The goal of the program is to obtain the information needed to plan and design facilities and equipment required to retrieve, transport, examine, treat, certify, and dispose of the retrievably stored TRU waste. The program is divided into three phases: (1) a study of existing records of TRU waste containers and contents (published as Ref. 4), (2) a visual and nondestructive testing inspection of containers in situ to determine integrity, plus nondestructive assay to analyze contents [reference 5 describes the inspection, currently planned for fiscal year (FY) 1991], and (3) a glovebox examination of contents of retrieved containers.

The integrity of containers is of interest from two standpoints. The first is assessment of current or future contamination leakage with potential spread to the surrounding environment, and the second is the impact on environmentally safe handling during retrieval of containers with breaches or no structural integrity. This report will describe the types of TRU waste containers in retrievable storage at the Hanford Site and their expected environment, the available data relating to corrosion rates of the containers, and expected degradation of the containers.

CONTAINER ENVIRONMENT

Transuranic-bearing wastes have been packaged in sealed containers and segregated from low-level (LLW) waste in retrievable storage trenches since May 1, 1970. Before then the TRU wastes were commingled and buried with the LLW. About 15,421 m^3 (544,500 ft^3) of wastes designated as TRU waste have been retrievably stored on the 200 Area plateau at the Hanford Site. These wastes consist of dry waste (e.g., soiled clothing, laboratory supplies, and tools packed in cardboard, wood, or metal containers) and industrial waste [primarily items of failed process equipment packaged in plastic shrouds, wood, fiberglass-reinforced polyester (FRP), metal, or concrete boxes]. The containers include 37,641 drums of 0.21-m^3 (55-gal) capacity, 329 metal boxes, 202 FRP boxes, 58 concrete boxes, 37 plywood boxes, and 462 other miscellaneous containers. The drums are predominantly painted carbon steel procured to the U.S. Department of Transportation (DOT) 17C or 17H specifications, although some galvanized steel drums were also used.

The containers have been stored in four different configurations. The first configuration used had containers stacked in a horizontal position in a gravel bottom "v" trench covered with soil. Later, a concrete "v" trench with a metal cover over drum containers was used for a short period of time. This mode of storage was abandoned because of the cost. The third configuration consisted of wide-bottom and "v" trenches with plywood bottoms and plywood sheeting between vertical stacks of drums. A plastic tarp was used to cover the top layer of containers and approximately a meter of earth was backfilled on top of the tarp. The fourth configuration was wide-bottom trenches similar to the third configuration with asphalt bottoms rather than plywood. Over 70% of the waste containers are in trenches of the fourth configuration. An example of the storage used in the fourth configuration is given in Fig. 1. In most cases, the waste drums were stacked in modules 12 drums long by 12 drums wide by 4 to 5 drums high, for an approximately 8-m-long by 8-m-wide by 5-m-high (26.2-ft by 26.2-ft by 16.4-ft) geometry. Boxes were stacked in single layers in the same modules as drums. Modules were separated by several feet in the trench. Each trench varied in length but

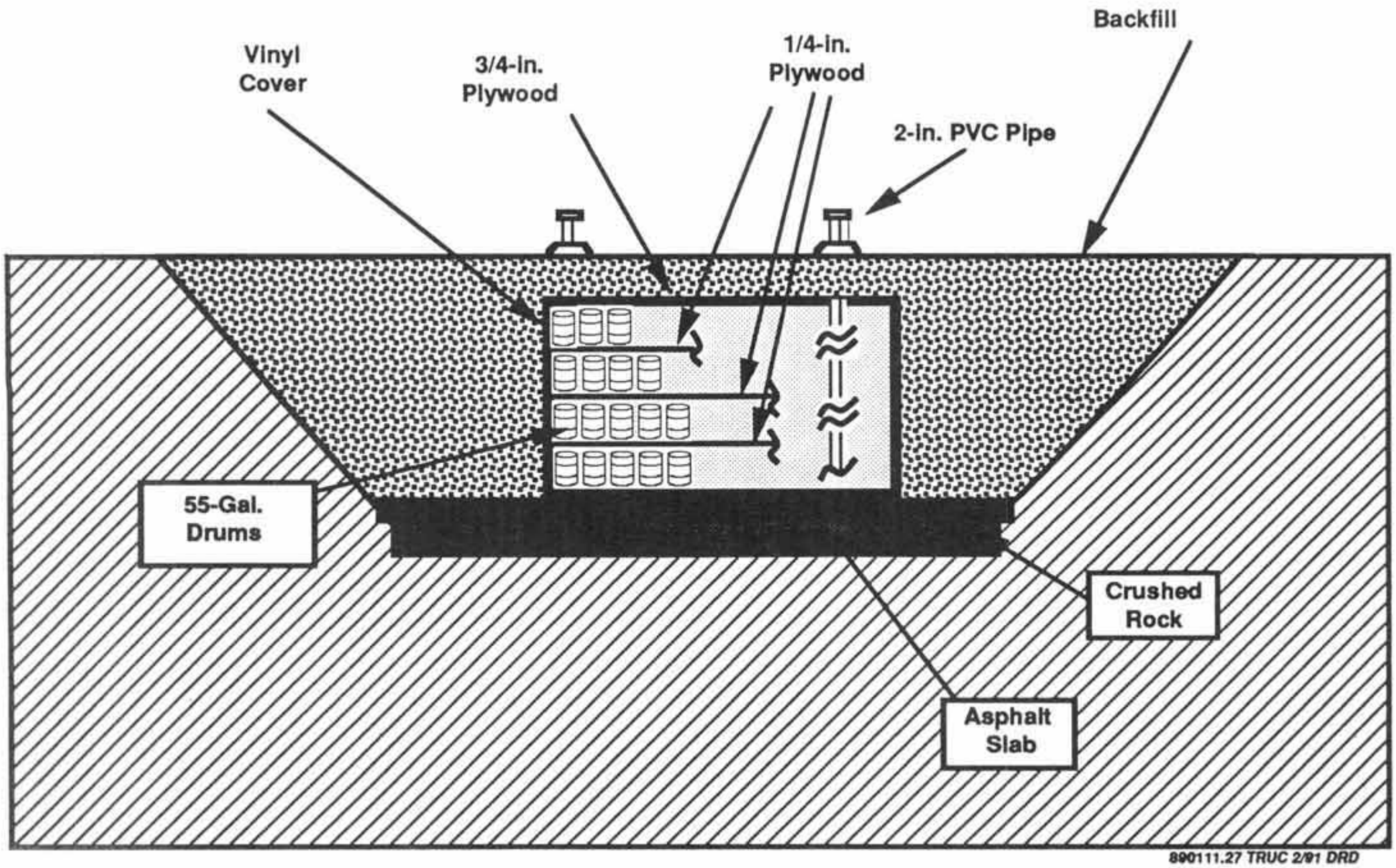

Fig. 1. Typical post 1973 transuranic waste storage.

could be as much as 150-m (492-ft) long. The bottom of the trench was 4-m to 6-m (13.1-ft to 19.7-ft) below grade.

AVAILABLE DATA

A large and widely varying body of data exists on soil and atmospheric corrosion on steel. The most applicable data would be those of similar containers in similar environments. Other DOE sites have examined waste drums stored under ground (6,7,8,9). At the Idaho National Engineering Laboratory (INEL), 65% of the drums stored for 18 to 21 yr were breached, with several containers having lost structural integrity. This corresponds to a median corrosion rate in the breached containers of approximately 0.102 mm/yr (4 mil/yr), assuming a DOT 17C nominal 1.52-mm (60-mil) wall thickness. This number was estimated from the assumption that a median corrosion rate would be that at which 50% of the drums had been breached. The assessment that 65% were breached with several containers having lost structural integrity implies two different failure modes, breach occurring in numerous drums and loss of structural integrity occurring in only a few. This would be consistent with pitting the corrosion mode responsible for localized damage in the breached drums, and general corrosion the mode responsible for the loss of structural integrity. There is not enough information for an accurate assessment of general corrosion rates, but 0.051 mm/yr (2 mil/yr) would not be unreasonable. In contrast, drum retrieval after 6 to 9 yr of burial under plastic covering at INEL yielded 2 of 102 drums with serious corrosion but no breaches. Plastic covering of drums in aboveground soil mounds at the Savannah River Site (with soil contacting the drums under the plastic) resulted in a maximum of over 24% wall thickness penetration after 8 yr of exposure.

There have been several assessments and examinations of corrosion of buried steel at the Hanford Site, in the two environments of direct soil burial and under plastic tarp covering. The oldest and perhaps the most comprehensive survey of direct soil effects was performed by Jaske (10), for a variety of buried piping materials. The observed corrosion rates averaged 0.114 mm/yr (4.5 mil/yr) for general corrosion and 0.229 mm/yr (9 mil/yr) for pitting corrosion. Other assessments of soil corrosion at the Hanford Site have resulted in similar rates.

There have been several investigations of corrosion under the tarp coverings. In 1982 an inspection was carried out with visual and ultrasonic techniques for drums stored for over 8 yr. The maximum measured corrosion corresponded to a rate of approximately .025 mm/yr (1 mil/yr). The maximum corrosion occurred on the drum surfaces touching the tarp because of a wicking effect that maintained moisture on the drum. In situ photography of drums within a storage module, through a vertical inspection port, was performed in 1981, 1982, 1983, and 1988. There were many areas of paint loss on drum surfaces but there was no visual indication that the underlying metal was penetrated by corrosion to any significant extent. The drums had been in the storage module for 7 yr.

Expected corrosion from a theoretical assessment of the environment will be discussed next. The Hanford Site soil moisture content varies with depth and surface precipitation but at the depth of the buried containers could range from near 0% to as much 10%. Typical Hanford Site soils are slightly alkaline with a pH near 8.0, resistivity approximately 5,000 ohm-cm, and low chloride content. It can be difficult to predict the corrosivity of soils, particularly a definite corrosion rate strictly from chemical and physical analyses, but the stated characteristics of Hanford Site soils would place them in a relatively nonaggressive category (11,12). Higher moisture contents, lower pH, lower resistivity, and greater chloride content would tend to cause greater relative corrosivity. The most extensive survey of soil corrosion was performed by the National Bureau of Standards [now the National Institute of Standards and Technology (NIST)]. Soils from the NIST study which were similar to Hanford Site soils led to general corrosion rates from 0.076 mm/yr (3 mil/yr) to 0.203 mm/yr (8 mil/yr). Relative to the Hanford Site, the soils at Idaho Falls are roughly comparable but have a higher moisture content, a higher ionic content, and are less alkaline, which should lead to greater corrosion rates. This is in contrast to the data discussed above, which indicates more rapid soil corrosion at the Hanford Site than at INEL.

Tarp coverage to avoid soil contact will lead to a slower, air atmosphere-type of corrosion. Atmospheric corrosion rates for a time span of 10 yr in an urban environment have been reported as averaging 0.013 mm/yr (0.5 mil/yr)(13). High humidity conditions may lead to higher corrosion rates but this is not always the case.

EXPECTED CONTAINER INTEGRITY

Carbon Steel

Existing data at the Hanford Site lead to estimates of the pitting corrosion rates averaging 0.229 mm/yr (9 mil/yr) and general corrosion rates of 0.114 mm/yr (4.5 mil/yr). The

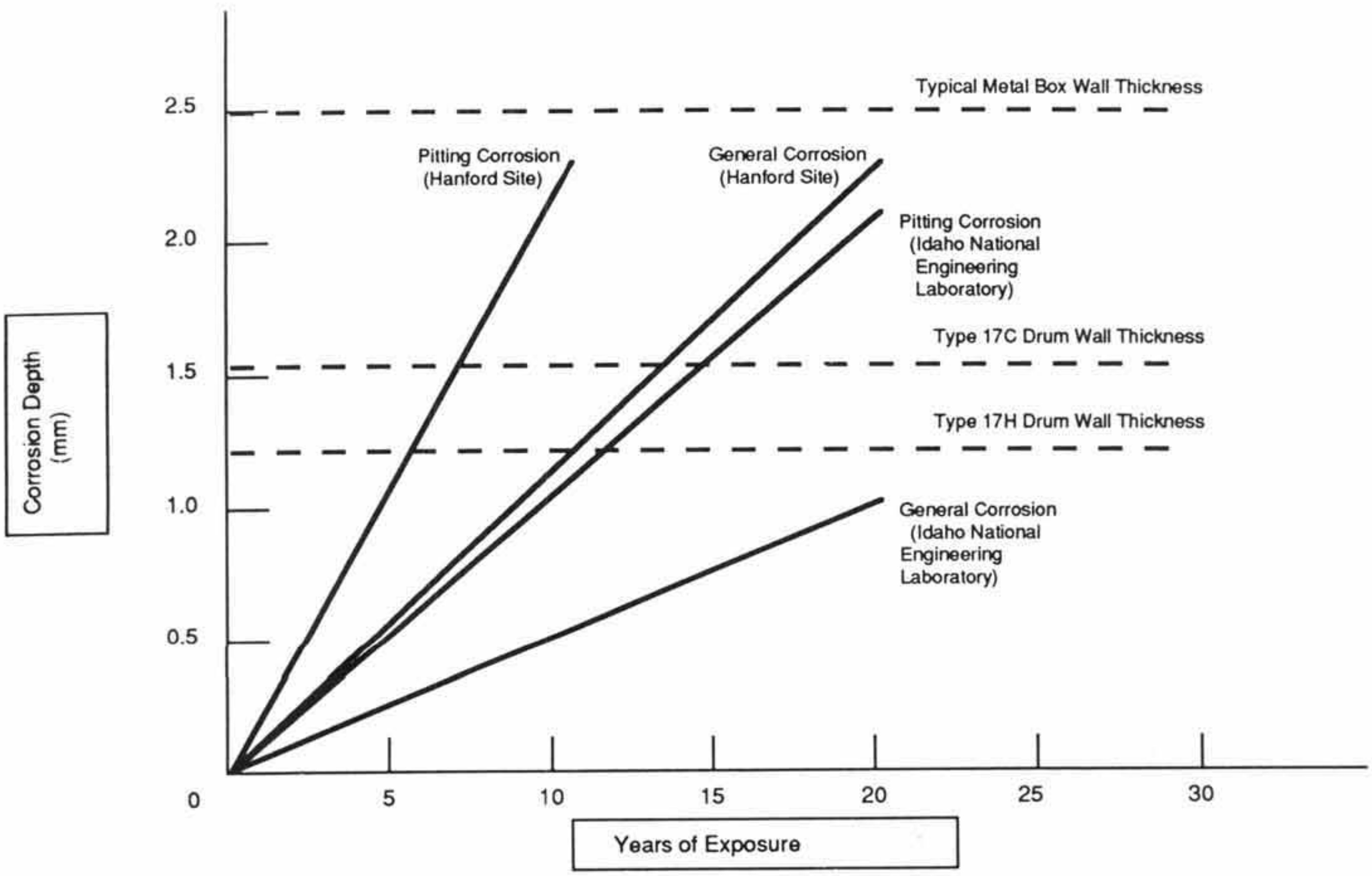

Fig. 2. Soil corrosion rate estimated from existing data.

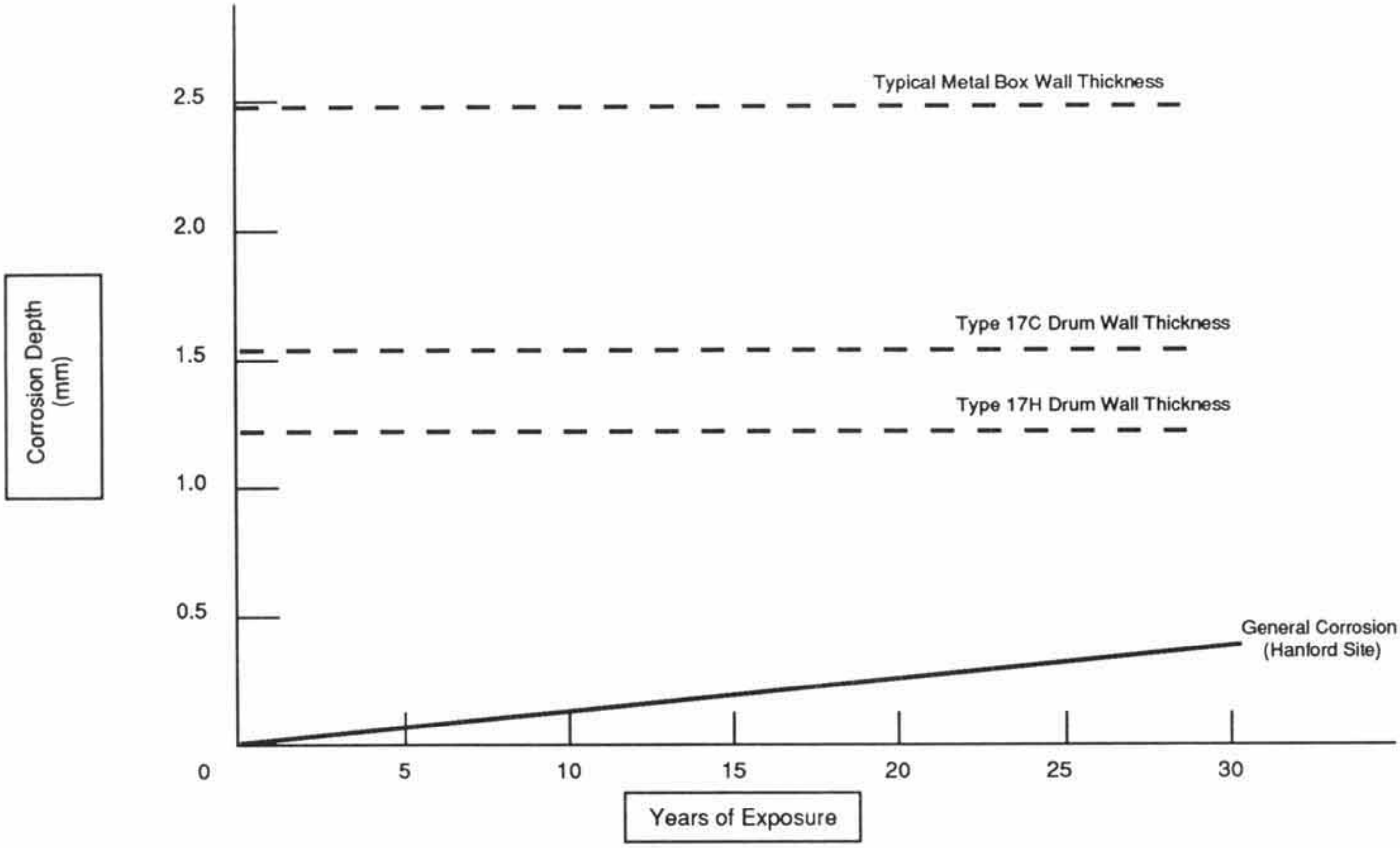

Fig. 3. Atmospheric corrosion rate estimated from existing data.

distinction between the two corrosion modes is important; pitting corrosion occurs more quickly but typically causes small holes and may not impact the structural integrity of the container as far as handling, assuming patching and contamination fixing could be adequately performed. General corrosion removes metal over large areas and would render the container unsuitable for any handling if the corrosion was extensive enough. These rates are felt to be conservative, because the materials in Jaske (Reference 10) were largely uncoated steel and the waste containers will be painted. Also, the results from the INEL soils that would be expected to be similar to or more corrosive than those at the Hanford Site, had corrosion rates roughly less than one-half of those from the Jaske report. The corrosion rates from the Jaske set were chosen as the preferred basis for corrosion rates as actual data are always preferable to theory.

The storage conditions under the plastic tarp should be much more benign, corresponding to an air atmosphere rather than a soil environment. Based on the limited measurements and observations available, the corrosion mode under the tarp covers seems to be general corrosion and proceeding at less than 0.025 mm/yr (1 mil/yr) on the average, as a worst case single measurement at the Hanford Site was 0.025 mm/yr (1 mil/yr). A reasonable assumption for an average rate of general corrosion would be 0.013 mm/yr (0.5 mil/yr).

The estimates for depth of corrosion based on the available data are shown in Figs. 2 and 3 as a function of time. The wall thicknesses of the drums stored in the trenches are given on the graphs, to show the point in time full wall penetration should occur. Figure 2 illustrates that (using the Hanford Site data presented by Jaske) any drums exposed directly to soil should be pitted through and in poor shape structurally after less than 20 yr. The containers in "configuration 1" storage in the Hanford Site retrievable storage units, which amount to approximately 23% of the total containers and 22% of the drums, were buried directly in soil. They have been in storage for 17 to 21 yr. Metal boxes were typically 2.5 mm (0.1 in) and also should be seriously degraded. The rates from INEL data are also shown for comparison; they show much slower corrosion rates. Figure 3 presents an estimate of the atmospheric general corrosion rate expected under a tarp covering in the retrievable storage units from the Hanford Site data. It is believed that the INEL results corroborate the rate shown in Fig. 3. No breaches would be predicted. Structural integrity for handling purposes should remain. Approved criteria for addressing structural integrity in handling containers remain to be developed.

There are sure to be occasional variations in the storage environment, such as breaks in the tarp that allow soil ingress, which will result in faster rates of degradation than stated above. Also, there may be some breaches because of internal corrosion. No internal corrosion should occur if the waste was packaged properly (no liquids, plastic liners, etc.), but there may be some because of improper packaging. This is impossible to predict.

Other Materials

The concrete containers should suffer little degradation. Within 5 to 10 yr the plywood boxes should rapidly degrade from bacterial rot from the soil exposure or high humidity environment under the plastic tarps. This is based on the information from the INEL studies. The condition of the fiberglass coated boxes is unknown. The only available data on the condition of this type of material after underground exposure is from the INEL reports; the fiberglass boxes had "no apparent degradation." However, the structural members underneath the fiberglass exterior panels are wooden and could be rotten if moisture has penetrated through the exterior; this would not be apparent from a visual inspection.

FUTURE PLANS

The characterization effort to sample in situ the condition of the retrievably stored TRU waste containers will be initiated this fiscal year. Sixteen to nineteen separate sites in the retrievable storage unit trenches will be excavated. Several hundred drums will be inspected visually in the trenches and with ultrasonic techniques to determine wall thickness. Approximately 200 of the drums will also be retrieved to investigate contents with nondestructive radiographic examination and active/passive neutron assay and possibly with physical inspection in a glovebox. Several boxes of each material type (metal, concrete, fiberglass-reinforced polyester, and plywood) will be inspected in the trenches by visual and nondestructive examination (NDE) techniques. Several means of NDE will be used. Ultrasonic inspection will be used on the metal boxes. Less conventional NDE techniques are being developed for the other materials. Pulse echo, pulse velocity, resonant frequency, and impulse radar methods are now under development. The first three techniques use analyses of shock waves induced in the structures to determine the soundness of the materials. The data from the characterization program will be used to guide planning for subsequent full-scale retrieval. The results will dictate retrieval sequence to minimize the difficulty of retrieving containers in a degraded condition.

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