

Hanford Waste Transfer Planning and Control – 13465

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ABSTRACT

Hanford tank waste cleanup requires efficient use of double-shell tank space to support single-shell tank retrievals and future waste feed delivery to the Waste Treatment and Immobilization Plant (WTP). Every waste transfer, including single-shell tank retrievals and evaporator campaign, is evaluated via the Waste Transfer Compatibility Program for compliance with safety basis, environmental compliance, operational limits and controls to enhance future waste treatment.

Mixed radioactive and hazardous wastes are stored at the Hanford Site on an interim basis until they can be treated, as necessary, for final disposal. Implementation of the *Tank Farms Waste Transfer Compatibility Program* helps to ensure continued safe and prudent storage and handling of these wastes within the Tank Farms Facility.

The *Tank Farms Waste Transfer Compatibility Program* is a Safety Management Program that is a formal process for evaluating waste transfers and chemical additions through the preparation of documented Waste Compatibility Assessments (WCA). The primary purpose of the program is to ensure that sufficient controls are in place to prevent the formation of incompatible mixtures as the result of waste transfer operations. The program defines a consistent means of evaluating compliance with certain administrative controls, safety, operational, regulatory, and programmatic criteria and specifies considerations necessary to assess waste transfers and chemical additions.

Current operations are most limited by staying within compliance with the safety basis controls to prevent flammable gas build up in the tank headspace. The depth of solids, the depth of supernatant, the total waste depth and the waste temperature are monitored and controlled to stay within the Compatibility Program rules. Also, transfer planning includes a preliminary evaluation against the Compatibility Program to assure that operating plans will comply with the Waste Transfer Compatibility Program.

INTRODUCTION

Hanford tank waste cleanup requires efficient use of double-shell tank space to support single-shell tank retrievals and future waste feed delivery to the Waste Treatment and Immobilization Plant (WTP). Every waste transfer, including single-shell tank retrievals and

evaporator campaign, is evaluated via the Waste Transfer Compatibility Program for compliance with safety basis, environmental compliance, operational limits and controls to enhance future waste treatment.

Mixed radioactive and hazardous wastes are stored at the Hanford Site on an interim basis until they can be treated, as necessary, for final disposal. Implementation of the *Tank Farms Waste Transfer Compatibility Program* [1] helps to ensure continued safe and prudent storage and handling of these wastes within the Tank Farms Facility.

The *Tank Farms Waste Transfer Compatibility Program* is a Safety Management Program that provides a formal process for evaluating waste transfers and chemical additions through the preparation of documented Waste Compatibility Assessments (WCA). The primary purpose of the program is to ensure that sufficient controls are in place to prevent the formation of incompatible mixtures as the result of waste transfer operations. The program was established to provide a single process for evaluation of waste transfers to ensure the transfer did not create wastes that were outside of the safety analyses assumptions, environmental regulations and operational limits for the Hanford tanks. The program defines a consistent means of evaluating compliance with certain Administrative Controls, safety, operational, regulatory, and programmatic criteria and specifies considerations necessary to assess waste transfers and chemical additions.

DISCUSSION

Specific decision rules may apply to all of the tanks or may only apply to a specific tank (e.g., Feed Control List), class of tanks (e.g., single-shell tanks vs. double-shell tanks), or to a specific facility (e.g., 242-A Evaporator). The decision rules implemented via the Waste Transfer Compatibility Program are divided into the following categories:

- Tank Farms Administrative Controls,
- 242-A Evaporator Administrative Controls,
- Safety,
- Regulatory,
- Programmatic, and
- Operational.

Several of these will be discussed.

Tank Farms Administrative Controls

The most limiting of these rules is the Tank Farms Administrative Controls. Careful planning is required to assure that waste transfers comply with these controls. Often, a series of waste transfers are necessary to implement the compliant plan.

The Tank Farms Administrative Control (AC) decision rules implement specific aspects of the

following ACs:

- AC 5.8.1, “Double-Shell Tank Induced Gas Release Event Evaluation,”
- AC 5.9.1, “Double-Shell Tank and Single-Shell Tank Time to Lower Flammability Limit,”
- AC 5.9.4, “Waste Characteristics Controls,” and
- AC 5.9.5, “Nuclear Criticality Safety”

Current operations are most limited by staying within compliance with the safety basis controls to prevent flammable gas build up in the tank headspace. The depth of solids, the depth of supernatant, the total waste depth and the waste temperature are monitored and controlled to stay within the Compatibility Program rules.

There are two mechanisms by which waste-generated flammable gases can reach high concentrations in tank farm facilities. First, flammable gases generated by the waste are continuously released into vapor spaces. In the absence of adequate ventilation, the steady-state concentration of these gases can potentially exceed the lower flammability limit. Second, a fraction of the gas generated by the waste can be retained within the waste. This retained gas can be released in a spontaneous or induced gas release event (GRE) thereby increasing the flammable gas concentration in a tank headspace to above the lower flammability limit.

Hydrogen is the dominant flammable gas component, with minor contributions from methane and ammonia. The steady state tank headspace is calculated by determining the hydrogen generation rate based on waste composition and temperature and then evaluating the time required to reach 25% of the lower flammability limit assuming zero ventilation. The empirical rate equation for hydrogen generation in Hanford Site waste contains contributions from thermal reactions, radiolysis of water and organic, and corrosion. This rate equation is a function of waste composition (total organic carbon, Al⁺³, Na⁺, NO₂⁻, NO₃⁻, and OH⁻), radiation dose, temperature, liquid fraction, and tank wetted area. Both the thermal and organic radiolysis rates follow Arrhenius behavior. These radiolysis rates use an activation energy that is derived.

The Hanford tanks have been grouped into three categories based on the evaluation of waste tank characteristics and the propensity of the waste to experience a large gas release event. Waste group selection criteria were developed based on both empirical data and theoretical physical relationships with the objective of identifying and separating waste tanks into groups that posed similar gas release event risks.

The tanks are assigned to one of three groups as described below:

- **Waste group C:** Tanks with no potential GRE flammable gas hazard. That is, tanks that are conservatively estimated to contain insufficient retained gas to achieve 100% of the lower flammability limit, even if all of the retained gas is released into the tank headspace.
- **Waste group B:** Tanks with a potential induced GRE flammable gas hazard, but no potential spontaneous gas release event flammable gas hazard. That is, tanks that are conservatively estimated to contain sufficient retained gas to achieve 100% of the lower

flammability limit if all of the retained gas is released into the tank headspace, but are not waste group A tanks (see below).

- **Waste group A:** Tanks with a potential spontaneous gas release event flammable gas hazard in addition to a potential induced GRE flammable gas hazard. That is, tanks that are conservatively estimated to achieve a flammable gas concentration of 100% of the lower flammability limit in the tank headspace if all of the retained gas is released from a spontaneous GRE.

Prohibited activities (without prior written approval from the U.S. Department of Energy, ORP manager) include waste transfers into Waste Group A tanks and operations that would result in re-designation of a Waste Group B or C tank as a Waste Group A tank. Therefore, careful planning is required to assure that waste transfers will not result in creation of a Waste Group A tank. Hanford has five double-shell tanks that are categorized as Waste Group A, ten are Waste Group B and thirteen are Waste Group C.

In order to evaluate a tank for Waste Group assignment, the following data is required:

- Total waste depth
- Sludge depth
- Supernatant depth
- Sludge density
- Supernatant density
- Waste temperature
- Void fraction
- Sludge waste yield stress
- Hydrogen generation rate

Transfer planning includes a preliminary evaluation against the Compatibility Program to assure that operating plans will comply with the Waste Transfer Compatibility Program [2]. Retrieval of waste from the Hanford 241-C single-shell tank farm into double-shell tanks 241-AN-101 and 241-AN-106 are controlled as shown in the Figures 1 and 2 to avoid creation of Waste Group A tanks. The values shown on the figures represent the calculated median values for whether the waste can retain enough gas for the solids to become buoyant (Buoyancy Ratio [BR]) and whether the waste has enough potential energy to liquefy the buoyant region and have a large gas release (Energy Ratio [ER]). Tanks must exceed a BR of 1 and an ER of 3 to be susceptible to large spontaneous gas releases.

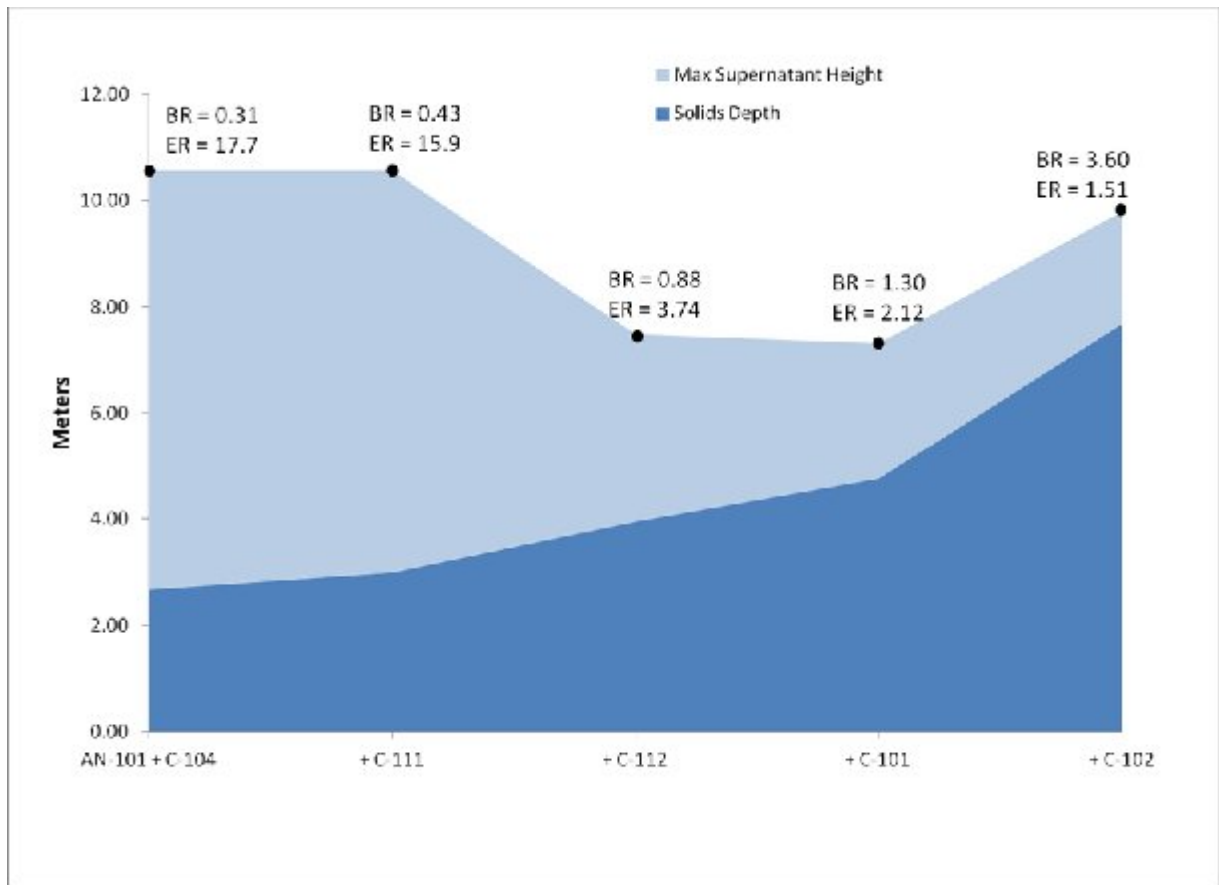


Figure 1. 241-AN-101 Waste Depths through C Farm Retrieval

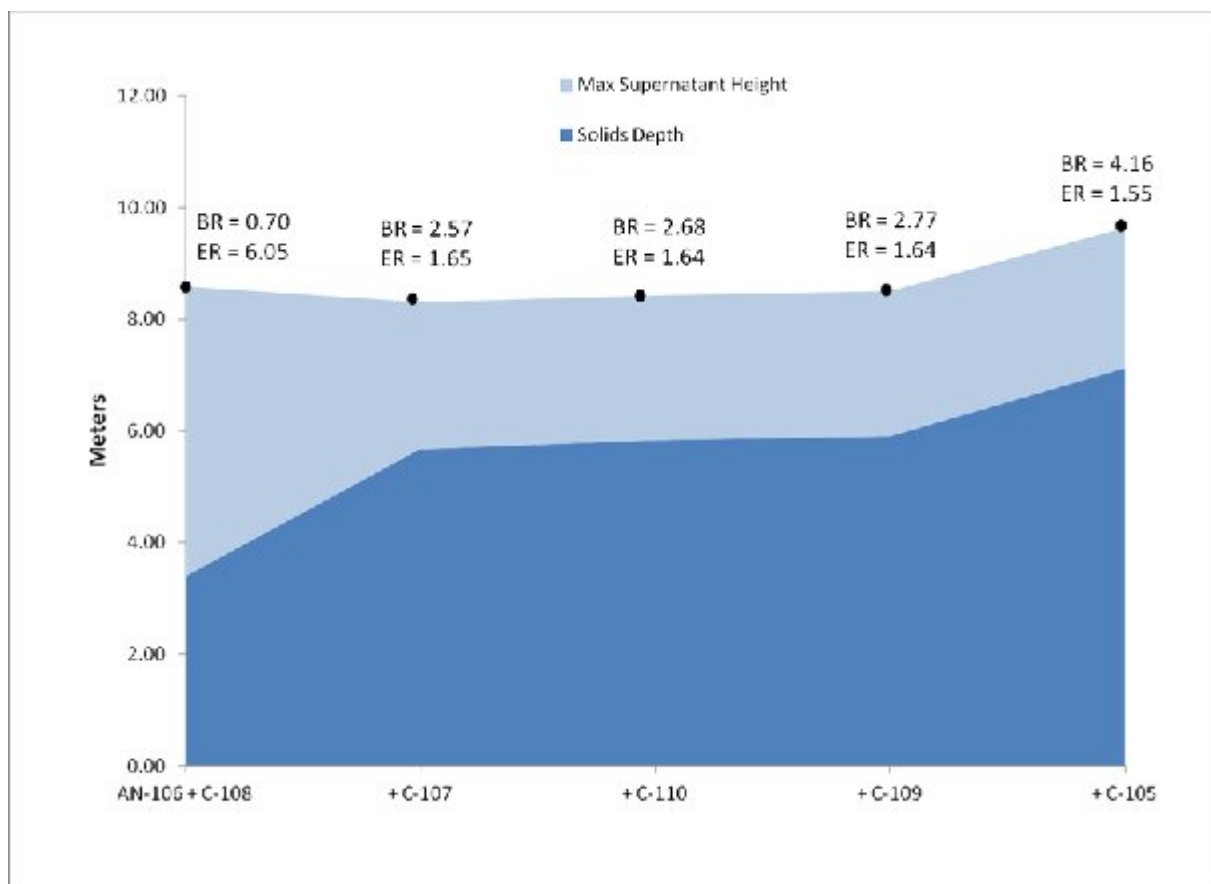


Figure 2. 241-AN-106 Waste Depths through C Farm Retrieval

The data show that the final supernatant heights will have to be controlled to a maximum of 83-inches in 241-AN-101 and 99-inches in 241-AN-106. As sludge depths reach approximately 150 inches, the amount of supernatant allowed dramatically decreases. This is because ER becomes the controlling factor for Waste Group assignment. Therefore, the Waste Group assignment can be controlled by maintaining the ER less than 3.0, which can be achieved by reducing the supernatant height. Periodic transfers are required to maintain the supernatant level below the maximum allowed value.

Safety Rules

The safety decision rules are focused on implementation of Nuclear Criticality Safety Program requirements. The waste compatibility program ensures that the pH, the fissile material concentration, and the amount of insoluble neutron absorbers in waste receipts from facilities interfacing with the tank farm facilities are controlled to ensure the margin of sub-criticality is maintained via the form and distribution of the wastes.

Regulatory Rules

The regulatory decision rules include requirements from the *Double-Shell Tank Waste Analysis Plan* [3] including:

- Waste Stream Profile Sheet,
- Chemical Compatibility, and
- Polychlorinated biphenyl (PCB) Management.

Programmatic Rules

Programmatic decision rules identify wastes that are under configuration control for purposes of protecting feed delivery to the Waste Treatment Plant (WTP). A feed control suite has been developed to ensure maintenance of double-shell tank space, to ensure timely characterization of adequate feed for the Waste Treatment and Immobilization Plant (WTP) hot commissioning and operating phases, and to support accelerated single-shell tank retrieval activities.

Operational Rules

Operational decision rules screen waste to be transferred against criteria aimed at preventing transfer line plugging and inadvertent solids precipitation. Operational decision rules screen the final state of source and receiver double-shell tank with tank chemistry controls, tank bump control, and hydrostatic load control specified in the *Operating Specifications for the Double-Shell Storage Tanks* [4]. The chemistry control limits protect the double-shell tanks from excessive corrosion by maintaining the waste at a high pH (generally greater than 12) and at a specific nitrite concentration. Chemical reactions deplete the hydroxide concentration during retrieval operations due to aluminum compounds in the waste and carbon dioxide absorption. Therefore, regular sampling events are planned during retrieval operations and sodium hydroxide solution is periodically added to tanks.

CONCLUSIONS

Prior to execution of a planned waste transfer, the proposed transfer shall be evaluated to ensure that the transfer will comply with the Waste Compatibility Program. The transfer activities are often evaluated well in advance so that when the final waste compatibility assessment is prepared, there are no unexpected limitations on completing the transfer. Through this program, the retrieval of Hanford single-shell tank waste into limited double-shell tank space is being successfully implemented.

REFERENCES

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