Evaluation of Alternatives for Hanford 327 Building Hot Cell Removal and Transport

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ABSTRACT

The Department of Energy (DOE) Hanford site 327 Building, built in 1953, played a key role in reactor material and fuel research programs. The facility includes nine shielded hot cells, a fuel storage basin, dry sample storage, and a large inerted hot (SERF) cell. In 1996, the 327 Building was transferred from Pacific Northwest National Laboratory (PNNL) to Fluor Hanford, Inc., to begin the transition from the mission of irradiated fuel examination to stabilization and deactivation. In 2001, a multi-contractor team conducted a review of the concept of intact (one piece) removal, packaging, and disposal of the 327 hot cells.

Alternatives

This paper focuses on challenges related to preparing the 327 Building hot cells for intact one-piece disposal as Low Level Waste (LLW) at the Hanford Site. These challenges, described in this paper, are threefold and include:

- Sampling and characterization of the cells for low level waste designation
- Packaging of the cells for transportation and waste disposal
- Transportation from the facility to the disposal site

The primary technical challenges in one-piece removal, packaging, and disposal of the hot cells involve the techniques required to characterize, remove, handle, package and transport a large (approximately up to 12-feet long and 8-feet high) contaminated object that weighs 35 to 160 tons.

Specific characterization results associated with two hot cells, G and H cells will be reported. A review of the activities and plans to stabilize and deactivate the 327 Building provides insight into the technical challenges faced by this project and identifies a potential opportunity to modify the baseline strategy by removing the hot cells in one piece instead of decontaminating and dismantling the cells.

INTRODUCTION

The 324/327 Multi-Year Work Plan provides the approved baseline cost, schedule, and technical approach for the 327 Building Deactivation Project. During FY-2000 and FY-2001, independent reviewers conducted two technical evaluations of the technical baseline. Both reviews suggested potential schedule and cost benefits if the baseline approach could be changed to monolithic removal of the hot cells and disposal with no or little decontamination. The most recent and most detailed review, Evaluation of Alternatives for 327 Building Hot Cell Cleanout, identified three conditions that must be met for monolithic removal to be successful. The first of these conditions is an assurance that the cells can be disposed of as non-transuranic waste. Sampling and identification of decontamination requirements is required before a decision to abandon the technical baseline can be made. The other challenges include packaging the cells for transport and waste disposal, and transport of the disposal site.

The overall process flow for intact disposal of the 327 facility Hot Cells is defined in Figure 1. This process flow includes the steps to sample and characterize the hot cells to certify the waste inventory, prepare the package and transport the package to the waste disposal site.

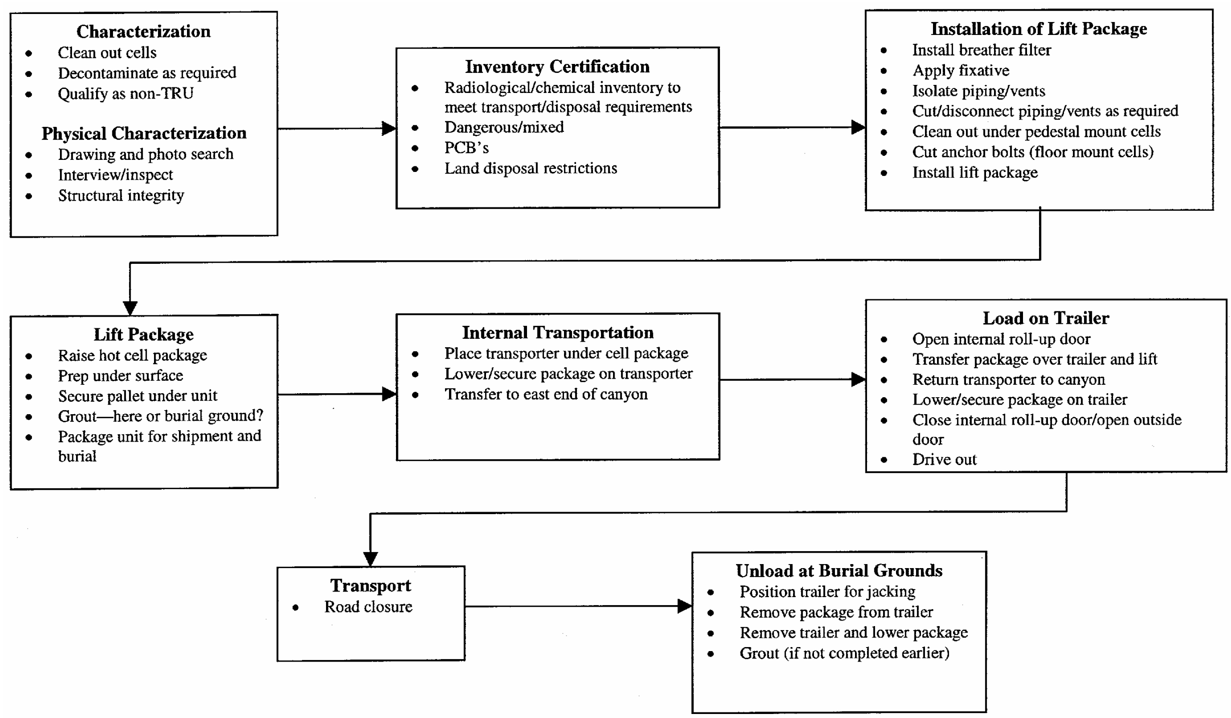

Figure 1 - 327 Building Cleanout Process Flow Summary

Objective

The overall strategy for sampling and characterization of the hot cells is to efficiently deploy the available characterization tools that provide acceptably accurate results and minimize cost, schedule impact and potential personnel exposure.

The Data Quality Objectives (DQO) process, based on the purpose for the characterization activity, defines the specific decisions that must be made, addresses the parameters and constituents of concern and their regulatory limits, and defines the decision rule(s) to achieve the desired goal. The seven major steps in the DQO Process described in DOE-1 have been used as guidance to state the DQO.

Facility Description

The 327 facility, also known as the Postirradiation Testing Laboratory (PTL), provided shielded, ventilated, and specially equipped hot cells and laboratories for physical and metallurgical examination and testing of irradiated fuels, concentrated fission products, and irradiated structural materials. The facility contains 10 high density iron or steel shielded hot cells in a main operating area or canyon. Figure 2 shows H cell as a typical hot cell in the canyon. Nine of the cells are constructed of meehanite cast iron in keyed block format. The facility mission is complete and the facility is being deactivated and cleaned out for demolition.

Figure 2 – 327 Building H Cell

The facility has a long, varied and productive history. Completed in 1953 with four hot cells, the original mission was to provide a safe system to obtain data, which would lead to minimizing ruptures of production fuel elements. The mission was soon expanded to many other areas, a few of which include:

- Surveillance and rupture/failure analysis for fuel elements and materials for Hanford production and test reactors including the N Reactor, Plutonium Recycle Test Reactor (PRTR), EBR-II, gas cooled fast reactor, Fast Flux Test Facility (FFTF), and others.
- Evolution from aluminum to zirconium clad metal fuels and use of stainless steel cladding.
- Examination of plutonium oxide – uranium oxide fuels and the introduction of higher enrichment fuels, plutonium impregnated graphite, and space power fuel pins.
- Waste tanks sludge examination and cesium chloride capsules, fuel emitters and thermionics materials.

This varied and productive history now presents waste management issues that confront facility management for the cost effective disassembly or demolition of the hot cells of the facility.

SAMPLING AND CHARACTERIZATION OF THE CELLS FOR WASTE DESIGNATION

Intact waste disposal of the 327 Facility hot cells is premised on obtaining a radiological waste designation as low-level waste. Radiological constituents above low-level concentrations will prevent the hot cells from being disposed on the Hanford site without supplemental decontamination or treatment. Mixed wastes, although not expected, are possible. Depending upon regulatory authority the 327 hot cells might be disposed under CERCLA authority at the Environmental Restoration Disposal Facility, under RCRA at the RCRA permitted disposal unit in the 218-W-5 Burial Ground, or under DOE at the Low Level Burial Grounds. Waste designation will be completed in accordance with BHI-00139, HNF-EP-0063, and/or Washington Administrative Code (WAC) 173-303 to ensure the applicable waste acceptance criteria are met for the selected waste disposal site.

Low-level waste is defined as radioactive waste that is not high level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material. Radionuclides of interest include transuranium and fissionable isotopes, and mobile radionuclides. Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years. Generally, any radionuclide that accounts for more than 1 percent of the total radiological activity of the waste must be quantified and radionuclides in concentration less than 1.0 E-6 curies per cubic meter are exempt from reporting.

Mixed waste is defined as any radioactive material which is no longer of use or value, and contains waste that either (A) is listed as dangerous waste in WAC 173-303, (B) causes the waste to exhibit any of the dangerous waste characteristics identified in WAC 173-303, (C) fulfils any of the "dangerous waste criteria" identified in WAC 173-303, (D) listed as hazardous waste in Subpart D, 40 CFR 261, or (E) causes the waste to exhibit any of the hazardous waste characteristics identified in Subpart C, 40 CFR 261. No mixed wastes are expected in the hot cells, however, the possibility does exist that paint used in the hot cell interior might contain lead, chrome or PCB's. In addition lead windows and other lead used for shielding may be present in the cells.

Radionuclide constituents will be quantified to confirm a low-level waste designation. Confirmatory samples will be obtained and analyzed to verify and quantify the hazardous constituents if present in the hot cells. Based on these results the waste disposal location will be selected.

Strategy Details

Consistent with the technology deployment plans associated with the 327 Hot Cell characterization and disposal, NDA techniques will be used to "demonstrate that the structures can be designated as low-level/waste (rather than transuranic [TRU] waste)". Selected NDA techniques including gamma profiling will be used to provide a radiological dose rate map of the hot cells and to measure dose rate from highly contaminated equipment within the cells.

Sampling and characterization techniques including NDA encompassed the following methods:

- Gamma camera results to map relative contamination areas and identify hot spots

- Fission chamber and copper foil results to quantify neutron flux and hence estimate the quantity of TRU in the cells.
- In-Situ Object Counting Systems (ISOCS) employing gamma spectroscopy to identify major radionuclides.
- Based on above results targeted sampling and laboratory analysis is pursued to provide detailed isotopic analysis of radionuclide contamination.

Computer models of the cell will be used to "account" for the dose rates measured during characterization activities. Using conservative assumptions a bounding estimate source term can be determined for each four potential sources:

- Surface contamination that includes non-removable contamination leached into the surface layer of cell surfaces. This contamination source is not significantly attenuated.
- Contamination that is immediately below the surface of cell liners or painted surfaces. This contamination is somewhat attenuated by the cell liners or surfaces.
- Contamination that is within contaminated equipment within the cell. This contamination that is highly shielded. For example, Cell C contains a false floor, under which a ventilation plenum exists. This plenum will have to be evaluated as a highly shielded source.
- Activated materials and secondary radiation. These are materials that have been activated by neutron activity within the cell or are a result of a high-energy beta interacting with dense materials. These expected to be a very minor source and may be demonstrated to be insignificant by dosimetry.

Using the source term inferred by the computer model and the ratios of isotopes determined from sampling data, a preliminary estimate of radiological inventory can be made. This estimate can be compared to solid waste acceptance criteria using the "sum of the fractions" methods required. From this preliminary estimate of the cells inventory a graded approach is used to determine the number of samples required to accurately characterize the cell.

The steps necessary to characterize the 327 hot cells support the following objectives:

<u>Objective 1: Develop a Contaminants List</u>. Characterizations of the 327 hot cells will requires review of process knowledge and development a list of potential radioactive and regulated contaminants that could reasonably have a significant impact on the characterization of the cell. The list of these contaminants is screened based on process knowledge based on waste acceptance criteria. (e.g. Radionuclides that contribute <1.0% are excluded)

<u>Objective 2: Use Non-Destructive Assay (NDA) Methods to Support Sampling Basis and Identify Specific Sampling Requirements.</u> Develop a model correlating cell measurements to cell inventory. This would include guidance for location of NDA equipment relative to cell walls any required shielding and geometry. The NDA data will be used to determine the appropriate confidence level and allowable error in the sampling strategy (See section on Graded Approach).

<u>Objective 3: Identify and Quantify Inventory in Specific Equipment and Known Areas of Extensive Contamination.</u> Identify known areas of significant inventory including, equipment, sumps, piping, exhaust ducting etc. This can be done by gamma camera and NDA in conjunction with process knowledge.

<u>Objective 4: Develop Sampling/Analysis Basis</u>. Develop sampling and analysis basis and requirements to determine general contamination, to confirm worst-case concentration and equipment/location specific samples. The equipment/location specific samples will be determined based on process knowledge and NDA measurements.

<u>Objective 5: Minimize Costs</u>. Using graded approach and applying worst case evaluations where possible, reduce the overall cost of sampling by minimizing the number of samples and analyses.

Worst Case for General Contamination and Matrixed Contamination

Determination of a cells inventory of a specific isotope or non-radioactive hazardous material may be determined using a "worst case" concentration. The worst case concentrations is determined using preliminary radiological smear data and calculating the resulting concentration taking into consideration the grout fill that will be required for the cells. For non-radioactive hazardous contaminants process history and a sample from the cell most likely to contain the hazardous contaminant is used. Table 1 identifies the major radionuclides of interest as documented in HNF-3435.

Table 1 - Major Radionuclide Contaminants Potentially Contributing > 1 % of Activity

Radionuclide	A Cell	B Cell	C Cell	D Cell	E Cell	F Cell	G Cell	H Cell	I Cell	SERF Cell
Mn-54								X		
Co-60								X		
Sb-125			X							
Cs-134		X	X							X
Cs-137	X	X	X	X	X	X	X	X	X	X
Eu-154										
Eu-155			X							
Am-241			X	X	X				X	X
Nb-94		X								
Ru/Rh-106			X							
Ra-226										
Sr-90			X	X	X	X	X		X	
Pu-239/240			X				X			
Pu-238/Am-241			X				X		X	
Cm-243/Cm-244			X							
Cm-242										

Other radionuclides of interest that may need to be quantified include the Uranium isotopes, specifically U-233, U-235, and U-238 if greater than 0.1 grams. Other mobile radionuclides such as Tc-99 and tritium require quantification if greater than 1 % of the activity or greater than 1 % of its Category 1 limit defined in HNF-EP-0063. Thorium, promethium, tantalum, chromium, thallium, hafnium, lanthanum, cerium, carbon, barium, radionuclides may also be present.

Table 2 presents a list of potential dangerous or hazardous contaminants. Sampling and analysis will be required to confirm the presence of any contaminants.

Table 2 - Potential Dangerous Contaminants List

Dangerous Waste Component	Basis for Inclusion
Pb	Lead or Lead Based Paints may have been used in the cell
Cr	Chromium or Chromium Based Paints
PCB	Paint and/or lubricants and oils used in process equipment in the cells.

The cell with the highest concentration, based on this methodology, is considered "worst case". This worst concentration may be used as the actual concentration of a given radionuclide or hazardous contaminant, when a significant cost or schedule benefit can be realized. Typically, this method will only be used when analysis for a specific isotope or hazardous constituent is cost prohibitive.

It is reasonable to assume that within each cell the floors of the cells are most highly contaminated areas (excluding specific equipment) due to the location of the ventilation and the effects of settling over time. It is therefore reasonable to believe that the highest surface concentrations of contaminants are located on the floor. This floor area is therefore selected as the region as the area to be sampled for general contamination.

It is also assumed that the floor represents the highest level of matrixed (embedded) contamination. This assumption is based on the tendency of process spills and upsets to accumulate on the floor. In addition, those mechanisms that cause contaminants to become embedded into the cell structural materials (absorption and chemical reactions) are typically a function of concentration, again assumed to be highest in the floor region of the cells, especially around any drains.

Based on this discussion, the cell floors should each be sampled to an appropriate level of statistical confidence. Samples should consist of surface smears of 100 cm2 and coupons of the floor material. The size of the coupons are not significant provided they can be weighed and their volume can be easily estimated. Weights and measurements will be used to estimate the total cell inventory.

Graded Approach and Confidence Level of Sampling Strategy

Hanford Waste Acceptance Criteria requires that confidence level of the sampling for characterizing the cell increase proportionally as the concentration of the radionuclides approaches the limit. For the hot cells the transuranic limit is 100 nCi/g. The Hanford Solid Waste Acceptance Criteria (HNF-EP-0063), Revision 6, Section 2.4.2 states,

> *"The radiological inventory of a waste must be established using a method or combination of methods capable of identifying and quantify the major radionuclides present. The methods chosen must provide adequate sensitivity and accuracy to ensure that the waste is categorized correctly…. A graded approach should be applied when planning radiological characterizations of waste streams. Using the graded approach more frequent and detailed analysis is performed when a waste approaches one or more of the limits of these criteria. Conversely, waste that is far below the applicable limits of these criteria would not require as extensive or frequent analysis…."*

Dose rates will be taken in each cell and compared to a MicroShield model of the cell floor. A portion of the measured dose will be attributed to contamination of the cells using the initial contamination data. The remaining dose will be attributed to contamination beneath the cell liner and equipment. This estimate will be conservative because it will be assumed that the source emanates from beneath cell liner and other coatings and thus will be estimated to be larger than a source distributed throughout the cell liner material. The resulting estimated source (based on the initial isotopic distribution) would be used to provide an initial "sum of the fractions" estimate.

The error rate and the confidence level will be scaled proportionally to the initial sum of the fractions estimate with error rate being varied between 5% and 30% and the confidence level being varied between 50% and 95%. Anything below a sum of the fractions value of 50% will be considered at the lowest confidence and highest error rate. Each value will be rounded to the nearest 5%.

Table 3 - Graded Approach for Sampling Based on Initial Evaluation of Radiological data

Initial Sum of the Fractions*	Proportional Confidence Level	Proportional Error Rate	No. of Random Samples Needed
<0.5	50	30	2
>0.5 and <0.6	60	25	4
>0.6 and <0.7	70	20	6
>0.7 and <0.8	80	15	10
>0.8 and <0.9	85	10	19
>0.9 and <1.0	95	5	58

* Based on Dose Rate readings from cells and initial radiological characterization from HNF-3435

This graded approach is used to minimize the number of samples, and hence the cost necessary to characterize the hot cells.

PACKAGING OF THE CELLS FOR TRANSPORTATION WASTE DISPOSAL

Nine hot cells in the 327 Building are constructed of Meehanite cast iron blocks each with massive sides, tops, and bottoms. Meehanite is a special process cast iron that has uniform density and consistent physical properties. The material has a tensile strength of 25,000 to 55,000 lb/in^2. Because it is a cast iron, Meehanite is not a high-ductility material; however, loading effects on the cell structure can be managed to keep the risk of brittle fracture low. A protective structure will be built around the cell that will minimize external loading and securely contain the structural elements that make up the cell unit. If necessary, this external structure may be pretensioned to reduce tensile stresses in the Meehanite blocks. Additionally, critical jacking and initial lifting of the cell will be accomplished within the 327 Building, where temperatures can be maintained at a moderate level. Based on the discussion and assumptions in this section, the recommended removal option is feasible with one issue identified.

> ***Physical characteristics of the hot cells need to be inspected to confirm as-built cell and facility interface configurations—****This is necessary to establish a technical basis for isolation and intact removal.*

The concept for lifting the floor-mounted cells will be to encase the cell in an external framework of structural steel members that "capture" the cell as a unit and prevent the cast iron blocks from shifting or coming loose as the unit is lifted and moved (see Figure 3). The major horizontal structural steel members around the lower portion of the cell unit will provide locations for jacking within the building and for lifting the unit later as needed. After the cell is released from its anchorage and lifted off the floor, a pallet or strongback will be placed underneath. This pallet will be attached to the other added external structure to provide the final lift package. The locations of the bolts that attach the cells to the base will be used to provide the structural tie between the cell and the exterior frame so that the unit can be lifted and the pallet placed underneath.

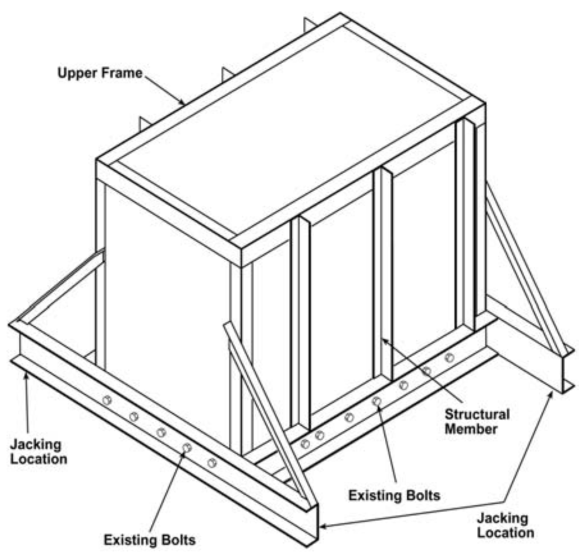

Figure 3 - Intact Hot Cell Package Concept

Hot cell package integrity will be established by the use of an integral frame, pallet, and strongback system to enclose the hot cell, ensure that it will not fall apart during normal transport conditions, and provide secure attachment points for an engineered transport tiedown system. All exterior surfaces will be decontaminated to the limits specified by the applicable authorization document (discussed below), and reinforced plastic will be wrapped around the hot cell prior to transport.

Figure 3 depicts the proposed packaging scheme for ensuring that the hot cells can be qualified for transport from the facility to the disposal site. Additional steel structural framework will be added to the top of the cell and to the vertical corners to stabilize the cell wall and keep the top blocks from moving. Finally, the upper and lower frames will be joined together with additional members to keep the individual blocks from shifting while the cell is being handled. The cell is now ready to be lifted from its attachment to the floor.

TRANSPORTATION FROM THE FACILITY TO THE DISPOSAL SITE

The critical parameter for any radioactive material packaging decision is the source term, which requires the specification and maximum quantities of each radioactive isotope and any other hazardous material. From the source term information, a general packaging type can be specified from 49 CFR 173 Subpart I, Class 7 "(Radioactive) Materials Regulations." The source term is used in any required safety basis analysis documentation (e.g., SARP) to show that the technical requirements for containment, shielding, and subcriticality are met. Information and scoping calculations to determine the proper packaging classification(s) for the 327 Building hot cells are summarized in this paper.

Even a relatively low-end packaging (such as a metal box) to meet DOT requirements would require a significant amount of work and expense. Construction of a box around the hot cell would likely need to be performed on the transporter and would not offer much technical benefit because the hot cell will be sealed and decontaminated already. Therefore, it is recommended that the transport "packaging" be the hot cell itself, and the transportation be performed under the onsite packaging and transportation program that is allowed under DOE Order 460.1A, *Packaging and Transportation Safety*.

Currently, the Hanford site is undergoing a major program revision in transportation safety documentation. This documentation, *Hanford Sitewide Transportation Safety Document (TSD)*, (DOE/RL-2001-0036, Draft) is in final review. This TSD defines the onsite transportation and packaging program at the Hanford site, which complies with the transportation safety requirements in DOE Order 460.1, *Packaging and Transportation Safety.* This change is driven by the DOE-RL Authorization Basis Division for implementation of the 10 CFR 830, Nuclear Safety Management final rule, of January 10, 2001. This rule will require the implementation of a site-wide "Transportation SAR" (Safety Analysis Review) as specified in DOE Order DOE-O-460.1, *Packaging and Transportation Safety*. The draft TSD when approved will meet this requirement.

For the hot cells, the packaging will primarily consist of the hot cell "intact," with residual internal radioactive contamination. A breather filter will be installed in the cell wall and fixative applied to the contaminated interior surfaces. In addition, the hot cell may be filled with grout to meet disposal requirements. Hot cell package integrity will be established by the use of an integral frame, pallet, and strongback system to enclose the hot cell, ensure that it will not fall apart during normal transport conditions, and provide secure attachment points for an engineered transport tiedown system. All exterior surfaces will be decontaminated to the limits specified by the applicable authorization document (discussed below), and reinforced plastic will be wrapped around the hot cell prior to transport.

Transport of the hot cell will require closure of the roadway from the 300 Area to the Wye barricade. This is a routine and proceduralized operation that has been used for many years on the Hanford site for packages that are approved by an onsite SARP. From HNF-PRO-157 (Fritz 2000): "All radioactive materials transported over onsite roadways that are open to the public (DOT definition of "in commerce") must be in compliance with DOT regulations. All shipments south of the Wye Barricade are considered "in commerce" and subject to DOT jurisdiction. This applies to both public access roadways and rail crossings with which they come in contact. If the shipment does not meet these regulations, transporting on the Hanford Site may be done during off-peak hours with the roads closed and/or crossings manned by Benton County Sheriff or Hanford Patrol to prevent public access to the shipment."

Precedent for this type of shipment has been established at Hanford. Two onsite SARPs are in place as an authorization basis:

- HNF-3341, Revision 0, Safety Analysis Report for Packaging (Onsite) Decontaminated Equipment Self-Container (Boehnke 1998)
- HNF-SD-TP-SARP-007, Revision 1, Safety Analysis Report for Packaging (Onsite) Flexible Material Packaging. (Boles 2000)

The continued use of these two SARP's is included in Appendix A of the draft TSD. Appendix A is divided in four parts; 1) packaging compliant with U.S. Department of Transportation packaging requirements, 2) packaging judged to meet equivalent packaging standards, 3) packaging judged to meet nonequivalent packaging standards, and 4) exemptions. These two SARP's are included in Part 3 Nonequivalent Packaging. Individual packages such as the intact hot cells will need to be screened against the authorized payloads in the SARP using the USQ process.

Preliminary evaluation of the F, G, and SERF cell source terms (Landsman et al. 1998, Table 4-1) indicates that the proposed hot cell packaging will meet the radiological limits specified by both of these onsite SARPs. Boehnke (1998) allows up to 100A_2 units, which the specified payloads clearly meet. Boles (2000) uses a “sum of the fractions” calculation methodology similar to that used to calculate an A_2. Scoping calculations indicate that the F, G, and SERF cell source terms specified in Landsman et al. (1998, Table 4-1) will meet the radiological limits specified in Boles (2000) by factors of 23, 19, and 10, respectively. Other physical (tiedowns, specific plastic wraps, etc.) and radiological (dose rate from package) limits are also specified in the SARPs, but preliminary evaluation indicates that the hot cell packages can be configured to meet those requirements. In the worst case, a revision to a SARP may be performed to clarify or evaluate any special technical areas that the proposed hot cell transport may present.

It is important to note, however, that alpha levels higher than used in this assessment may exceed the current SARP source term limits. For example, the source term specification from the draft BIO (FH 2000a), states that the plutonium holdup in each hot cell may be up to 15 grams. Using the ratio of isotopes from available data (based on 15 grams of ^{239}Pu), calculations show that neither of the previously mentioned onsite SARP source term limits can be met for this quantity of material. Note in this case it may be necessary to decontaminate the cells to meet the SARP limits even if the cells are designated LLW. This is indicative of a need for additional source term characterization and/or decontamination of the hot cells, and a possible need to perform additional safety basis analyses (via Engineering Change Notice and/or USQ process) related to the onsite SARP. Realistically, it is likely that the actual source term will lie somewhere between the BIO and Table 4-1 of Landsman et al. (1998), but source term characterization remains an issue to be resolved.

A second issue is related to future changes in the onsite safety program. These changes are nearly complete and will be finalized upon issuance of the new TSD. In the interim, DOE-RL has stated that Fluor Hanford, Inc. should maintain business as usual, and that existing onsite SARPs will be grandfathered into the new Transportation SAR. When the new SAR is in place, a USQ process will be used whenever a new payload or packaging type is needed.

As part of the new Transportation SAR, activities are already underway to define prescriptive packaging standards (anecdotally called “minimum packaging standards”) that will use 10 CFR 71, *Packaging and Transportation of Radioactive Material,* performance standards as a starting point and will allow lower levels of packaging performance in conjunction with other performance, administrative, and risk analysis measures. Because the hot cell payloads should not approach a Type B quantity following decontamination, demonstration of 10 CFR 71 packaging performance is not a concern; however, the USQ process (when developed) may need to be exercised to authorize this packaging and transportation campaign.

Based on the above evaluation, no insurmountable issues or concerns have been identified for the onsite transportation of the 327 Building hot cells as intact packages. Based strictly on the current knowledge of the radiological content, the hot cells will not need to be qualified to meet hypothetical accident conditions. An appropriately designed framing system may be used to enclose and secure the hot cell components to withstand handling and transportation conditions. Contamination will be fixed, and openings on the hot cells will be closed off.

It is not anticipated that the safety basis authorization for the onsite transportation of the hot cells will be an issue. Precedent for similar onsite packaging has been demonstrated by existing onsite SARPs for “self contained” equipment, and it is not anticipated that future program development would prohibit such shipments, especially as the cleanup of the Hanford Site moves toward decontamination and decommissioning (D&D) mode. Qualitatively, it is clear that the dose consequence to workers dismantling and packaging individual components of the hot cells will be much greater than the dose consequence of any postulated transportation accident with a one-piece hot cell.

CONCLUSIONS

Three challenges confronting intact hot cell disposal are discussed in this paper. These challenges include:

- Sampling and characterization of the cells for low level waste designation
- Packaging of the cells for transportation and waste disposal
- Transportation from the facility to the disposal site

These challenges are not insurmountable and based on preliminary data and the proposed characterization strategy it will be possible to characterize the hot cells as low level waste. Recent results on G and H cells confirm this premise that the hot cells can be designated as low-level waste.

Using the ratio of isotopes from available data (based on 15 grams of ^{239}Pu), Table 4 indicates that it will be possible to achieve a LLW designation for the hot cells (< 100 nCi/g). However, calculations show that neither of the previously mentioned onsite SARP source term limits can be met for this quantity of material. Note in this case it may be necessary to decontaminate the cells to meet the SARP limits even if the cells are designated LLW. This is indicative of a need for additional source term characterization and/or decontamination of the hot cells, and a possible need to perform additional safety basis analyses (via Engineering Change Notice and/or USQ process) related to the onsite SARP. Realistically, it is likely that the actual source term will lie somewhere between the BIO and Table 4-1 of Landsman et al. (1998), but source term characterization remains an issue to be resolved.

Table 4 - Calculated nCi/g Concentration Based on 15 g Plutonium

Cell	Estimated cell weight (tons)	Estimated cell weight filled with grout (tons)	Estimated nCi/g based on 15 g Pu^{239} and grouted cell weight(1)	Size, ft(2)	Wall Thickness, in.
A	155	180	7	9.5x4.5x8.17	18
B	60	70	19	6x4.3x4.3	15
C	40	450	29	6x4.3x4.3	10.5
D	40	45	29	6x4.3x4.3	10.5
E	40	45	29	6x4.3x4.3	10.5
F	145	170	8	8x5x8.17	18
G	95	135	10	10.25x6.25x8.3	10.5
H	50	60	22	5.3x4.6x7.1	10.5
I	35	40	33	4.3x4x5.17	10.5
Upper SERF	160	196	7	12x5x5	15-18

(1) Simple volume and weight calculation, cast iron density = 442 lb/ft^3.

(2) Interior dimensions; last dimension is height (Landsman et al. 1998).

With careful sampling and NDA based on a DQO process it will be possible to characterize and designate the cells as low level waste as demonstrated for G and H cells. However, transport issues may necessitate that the cells be decontaminated to achieve transport limits. The DQO process will help to ensure the cells are adequately characterized while minimizing cost and personnel exposure.

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