

ENGINEERING CHANGE NOTICE

Page 1 of 2

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13a. Description of Change Re-title document to "Hazard Classification For Fuel Supply Shutdown Facility." Revise methodology for classification of 303-K. Update classification for individual buildings, including the non-fuel storage buildings. Design verification performed by independent peer review.			
13b. Design Baseline Document? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 14a. Justification (mark one) Criteria Change <input checked="" type="checkbox"/> Design Improvement <input type="checkbox"/> Environmental <input type="checkbox"/> Facility Deactivation <input type="checkbox"/> As-Found <input type="checkbox"/> Facilitate Const <input type="checkbox"/> Const. Error/Omission <input type="checkbox"/> Design Error/Omission <input type="checkbox"/>			
14b. Justification Details Update facility classifications to reflect in-progress deactivation, and address non-fuel storage buildings.			
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HAZARD CLASSIFICATION FOR FUEL SUPPLY SHUTDOWN FACILITY

Prepared for the U.S. Department of Energy
Assistant Secretary for Environment, Safety and Health

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

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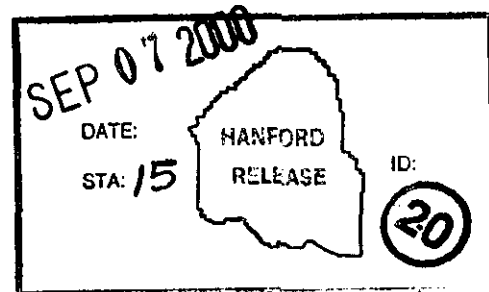
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HAZARD CLASSIFICATION FOR FUEL SUPPLY SHUTDOWN FACILITY

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Abstract: Final hazard classification for the 300 Area N Reactor fuel storage facility resulted in the assignment of Nuclear Facility Hazard Category 3 for the uranium metal fuel and feed material storage buildings (303-A, 303-B, 303-G, 3712, and 3716), Radiological for the residual uranium and thorium oxide storage building and an empty former fuel storage building that may be used for limited radioactive material storage in the future (303-K/3707-G, and 303-E), and Industrial for the remainder of the Fuel Supply Shutdown buildings (303-F/311 Tank Farm, 303-M, 313-S, 333, 334 and Tank Farm, 334-A, and MO-052).

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HAZARD CLASSIFICATION FOR FUEL SUPPLY SHUTDOWN FACILITY

1.0 INTRODUCTION

A final hazard classification has been prepared for the 300 Area Fuel Supply Shutdown (FSS) facility in accordance with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992) and HNF-PRO-704, *Hazard and Accident Analysis*.

A hazard classification (Huang 1999) previously prepared for the FSS facility led to the conclusion that the FSS should be declared a Nuclear Facility with a Moderate Hazard Class rating. The analysis and results contained in the hazard classification can be used to provide additional information to support other safety analysis documentation. Also, the hazard classification provides analyses of the toxicological hazards inherent with the FSS inventory; whereas, a hazard categorization prepared in accordance with DOE-STD-1027-92 considers only the radiological component of the inventory.

1.1 BACKGROUND

The FSS facility, consisting of various buildings formerly used for fuel fabrication, laboratories, concretion (mixing uranium fines and sludge with masonry cement), incinerating uranium and Zircaloy-2 fines, uranium special nuclear material storage, and offices (see Table 1.1) is located in the northeast corner of the 300 Area on the Hanford Site. Fuel fabrication, laboratories, concretion, and incinerator operations have been completely shutdown. The FSS facility is now used to store uranium billets, assembled and partially assembled fuel elements and scrap, canned uranium oxide and thorium oxide powder, and pelletized and sintered uranium oxide sealed within welded tubing, and is also used for office space. The FSS facility is currently undergoing transition activities required for turnover to the Environmental Restoration Contractor (ERC) for eventual decontamination and decommissioning (D&D).

1.2 SUMMARY AND CONCLUSIONS

A final hazard classification has been prepared for the FSS facility in accordance with DOE-STD-1027-92 (DOE 1992). For the uranium metal fuel storage buildings, the final hazard classification was prepared based on the unmitigated consequences of the most severe credible accident, i.e., an unmitigated fire in the 3712 Building that is used to store 675 MTU. These buildings are assigned a hazard classification of Category 3, since the radionuclide inventory is greater than Category 3 TQs, but the inventory at risk is less than the Category 2 TQs.

The radionuclide inventory of the building used to store residual uranium oxide and thorium oxide powders is less than the Category 3 TQs, resulting in its classification as Radiological. The remaining buildings have insufficient radionuclide inventory to designate them as Radiological and also have insufficient other hazardous substances to classify them as Non-Nuclear, which results in them being classified as Industrial. Table 1.2 summarizes the classification of each building based on the current operational status or planned usage.

Table 1.1. Fuel Supply Shutdown Facility Building Identification, Current Function/Activity.

BUILDING	CURRENT FUNCTION/ACTIVITY	INVENTORY (MTU)
303-A	Fuel Storage	122
303-B	Fuel Storage	52
303-E	Empty	None
303-F/311-Tank Farm	Shutdown Pump House/Outside Chemical Storage and Transfer System (Empty)	None
303-G	Uranium Billet Storage	210
303-K/3707-G	RCRA Closure/ UO ₂ & ThO ₂ Storage	3.5 (U), 0.5 (Th)
303-M	Uranium Oxide Facility (Shutdown & Empty)	None
304	RCRA Clean Closed, Empty	None
313-S	RCRA Closure Completed (Metal Fabrication in North end by private enterprise)	None
333	Offices/Cleanup, RCRA Closure	None
334 and Tank Farm	Empty	None
334-A	RCRA Closure, Empty	None
3712	Finished Fuel, Billet, & Scrap Storage	675
3716	Unfinished Uranium Fuel Storage	137
MO-052 Trailer	Offices	None

Note: "Empty" buildings have been emptied of fuel, hazardous materials, and equipment.

Table 1.2. Fuel Supply Shutdown Facility Building Identification and Hazard Classification

BUILDING	HAZARD CLASSIFICATION
303-A	Nuclear, Category 3
303-B	Nuclear, Category 3
303-E	Industrial
303-F/311-Tank Farm	Industrial
303-G	Nuclear, Category 3
303-K/3707-G	Radiological
303-M	Industrial
304	Industrial
313-South	Industrial
333	Industrial
334 and Tank Farm	Industrial
334-A	Industrial
3712	Nuclear, Category 3
3716	Nuclear, Category 3
MO-052 Trailer	Industrial

2.0 RADIOLOGICAL SOURCE TERM

The radiological source term for the FSS is based on a representative mixture composition of 0.009 wt% ^{234}U (5.8 E-01 Ci); 1.25 wt% ^{235}U (2.7 E-02 Ci); 0.069 wt% ^{236}U (4.7 E-02 Ci); 98.67 wt% ^{238}U (3.5 E-01 Ci); and 10 ppm ^{99}Tc for 1 Metric Ton Uranium (MTU) (Johnson 1994). The 3712 Building was initially analyzed as containing a radiological inventory of 1122 MTU available for release from a single building, based on the "worst case" accident (Huang 1999). However, the 3712 Building currently contains less than 675 MTU. Table 2.1 describes the basis radionuclide quantities for the 3712 Building. This inventory is also considered to be the basis for determining the inventory at risk for the FSS facility. Facility segmentation is permitted by DOE-STD-1027-92, as long as the hazardous material in one segment (or building) cannot interact with the hazardous material in other segments (or buildings). Since the heating, ventilation, and air conditioning (HVAC), and piping systems are independent among the various fuel storage buildings (i.e., there are no HVAC or process piping systems in these buildings that could allow hazardous material interaction) and there is a physical separation between the buildings, independence is demonstrated for facility segmentation purposes. Other buildings, with lesser inventory capacities, are also considered for hazard classification, as identified in Section 3.0.

Table 2.1. Radiological Source Term for the 3712 Building.

RADIONUCLIDE	COMPOSITION	1 MTU QUANTITY (Ci)	RADIONUCLIDE INVENTORY (Ci)
Uranium-234	0.009 wt%	5.8 E-01	391.5
Uranium-235	1.25 wt%	2.7 E-02	18.2
Uranium-236	0.069 wt%	4.7 E-02	31.7
Uranium-238	98.67 wt%	3.5 E-01	236.2
Technetium-99	10 ppm	1.7 E-01	114.7
Total U + ⁹⁹ Tc	100.00 wt%	1.17	792.3 ⁽¹⁾

(1) Based on 675 MTU in 3712 Building.

3.0 INITIAL HAZARD CLASSIFICATION

Per HNF-PRO-704 and DOE-STD-1027-92, the isotopic inventories of each of the fuel storage buildings were compared with the Category 3 threshold quantities (TQs) to establish the initial hazard classification. Table 3.1 displays this comparison for the 3712 Building, which has the maximum inventory of any of the storage buildings.

Table 3.1. 3712 Building Inventory Compared to Category 3 Threshold Quantities.

RADIONUCLIDE	3712 BUILDING INVENTORY (Ci) ⁽¹⁾	CATEGORY 3 TQ (Ci) ⁽²⁾	EXCEEDS CATEGORY 3 TQ
Uranium-234	391.5	4.2	YES
Uranium-235	18.2	4.2	YES
Uranium-236	31.7	4.2 ⁽³⁾	YES
Uranium-238	236.2	4.4	YES
Technetium-99	114.7	1.7E+03	NO

(1) Based on 675 MTU in 3712 Building.

(2) HNF-PRO-704, Table B-1

(3) Mandigo 1996

Since the inventory of at least one of the isotopes exceeds a Category 3 TQ, the 3712 Building is at least Category 3.

Examination of the nominal inventories of the other fuel storage buildings shows that the minimum quantity is 52 MTU in the 303-B Building. Although this inventory is slightly less than 8% of the 3712 Building inventory, it is noted that the U-234 activity exceeds the Category 3 TQ by a factor of about 7. Thus, even the 303-B fuel storage building is at least Category 3.

Next, the 3712 Building inventory was compared to Category 2 TQs (Table A.1, DOE 1992 and HNF-PRO-704), for individual radionuclides as shown in Table 3.2.

Table 3.2. 3712 Building Inventory Compared to Category 2 Threshold Quantities.

RADIONUCLIDE	3712 BUILDING INVENTORY (Ci) ⁽¹⁾	CATEGORY 2 TQ (Ci) ⁽²⁾	EXCEEDS CATEGORY 2 TQ
Uranium-234	391.5	2.2 E+02	YES
Uranium-235	18.2	2.4 E+02	NO
Uranium-236	31.7	5.5 E+01 ⁽³⁾	NO
Uranium-238	236.2	2.4 E+02	NO
Technetium-99	114.7	3.8 E+06	NO

(1) Based on 675 MTU in 3712 Building.

(2) HNF-PRO-704, Table B-1.

(3) HNF-PRO-704, Table B-1, footnote (a).

Since one of the radionuclides exceeds the Category 2 TQs, this would initially classify the 3712 Building as a Category 2 Nuclear Facility.

4.0 FINAL HAZARD CLASSIFICATION

In developing a final hazard classification, the DOE-STD-1027-92 standard allows for facilities initially classified as Hazard Category 2 to use the material at risk (MAR) associated with the unmitigated bounding accident. This method is used to classify the uranium storage buildings.

4.1 MATERIAL AT RISK

The final hazard classification determination was calculated using the credible MAR associated with the bounding uranium storage building fire.

Johnson 1994 reviewed existing uranium oxidation experimental data to predict billet oxidation during the postulated uranium storage building fire. Subsequent review of that study has led to the conclusion that the predicted oxidation rates were overly conservative. For example, after estimating the time for a uranium billet to oxidize completely at the predicted peak temperature, it was assumed that the storage building fire was at that peak temperature the entire

time instead of ramping up to that temperature and then cooling down once the combustible material was consumed. Furthermore, that oxidation time was then reduced by about 20%.

Re-examination of the 3712 building fire time-temperature profile (the ASTM standard time-temperature curve obtained from the Fire Protection Handbook) based on the combustible material loading shows that the temperature quickly reaches about 800°C in less than 30 minutes and then rises more slowly to reach 1000°C within 2 hours. Because extrapolation of the oxidation experiments indicates that billet oxidation would occur in approximately 170 hours at both 800°C and about 1000°C (Johnson 1994), that time is used to represent oxidation behavior up to 1000°C. Based on the fire temperature being at or above 1000°C from 2 hours to 4.5 hours, the oxidation time associated with the peak temperature (1093°C.), i.e., 124 hours (Johnson 1994), is assigned to that time period. After 4.5 hours, the fire cools to 300°C in another 3.5 hours. Although no oxidation behavior for the lower temperature range was indicated in the references cited in the accident analysis (Johnson 1994), a 200-hour oxidation period is conservatively applied to represent that temperature range because the oxidation rate is temperature dependent. Because of the mass of uranium associated with the postulated fire, it is believed that buildup of oxide "ash" would inhibit the oxidation process somewhat. Thus the fraction of billets oxidized during the fire would be conservatively represented by

$$2 \text{ hr}/170 \text{ hr} + 2.5 \text{ hr}/124 \text{ hr} + 3.5 \text{ hr}/200 \text{ hr} = 0.0494.$$

Treating oxidation of the clad fuel as though it were unclad billets is conservatively valid because a) the Zircaloy-2 cladding forms a protective adherent oxide coating that resists further oxidation (Johnson 1994), and b) although the ends of the unfinished fuel stored in the 3716 Building have no cladding, all fuel components are substantially longer than the diameter of the billets. Although Zircaloy-2 is designed primarily for nuclear reactor components, its oxidation resistance has been reported to be such that after approximately 100 hours in air at 650°C, an adherent protective coating measuring up to 300µm thick is formed (Sinha, et al 1987).

$$675 \text{ MTU} \times 0.0494 = 33.345 \text{ MTU}$$

Material at risk values for the 3712 Building fire are compared with Category 2 TQs in Table 4.1.

Table 4.1. Comparison of 3712 Building MAR to Category 2 TQs

RADIONUCLIDE	3712 BUILDING MAR (Ci) ⁽¹⁾	CATEGORY 2 (Ci) ⁽²⁾	MAR QUANTITY ÷ CATEGORY 2 TQ (Ci)
Uranium-234	19.34	2.2 E+02	8.8 E-02
Uranium-235	0.9	2.4 E+02	3.8 E-03
Uranium-236	1.6	5.5 E+01 ⁽³⁾	2.9 E-02
Uranium-238	11.7	2.4 E+02	4.9 E-02
Technetium-99	5.7	3.8 E+06	1.5 E-06
Sum of Fractions			0.17 < 1

(1) Based on 33.345 MTU at risk.

(2) HNF-PRO-704, Table B-1.

(3) HNF-PRO-704, Table B-1, footnote (a).

As shown in Table 4.1, the quantities of individual radionuclides associated with the MAR are less than Category 2 TQs and the sum of fractions of the isotopic MAR quantity to the Category 2 TQ ratio is less than 1 ($0.17 < 1$). Thus, the 3712 Building hazard classification is Category 3 Nuclear Facility.

Since each of the remaining uranium fuel storage buildings has already been shown to be at least Category 3 and each has less inventory than the 3712 Building (which has just been demonstrated to be Category 3), then these buildings are also Category 3. Thus the 303-A, 303-B, 303-G, and 3716 Buildings are Category 3. The radionuclide inventory associated with the low-level contamination on the fuel elements in 303-A and 303-B is insignificant compared to the fuel itself.

5.0 OTHER BUILDING HAZARD CLASSIFICATIONS

5.1 303-K/3707-G BUILDING

Tables 5.1 and 5.2 contain the quantities of the individual isotopes for the 303-K/3707-G Building. This building contains 2.192 MT depleted uranium, 1.27 MT natural uranium, and 0.470 MT Th (Appendix A). All these materials are in oxide form, either as sintered pellets or as powders. This inventory is considered to be the material at risk for the building. The uranium in this building is not the same uranium used for N Reactor fuel fabrication. Rather, it is a combination of natural uranium and depleted uranium that was associated with FFTF fuel and blanket assembly fabrication.

Table 5.1. Radiological Source Term for the 303-K/3707-G Building: 2.192 MT Depleted Uranium.

RADIONUCLIDE	COMPOSITION	303-K/3703G INVENTORY (g)	SPECIFIC ACTIVITY (Ci/g) ⁽¹⁾	INVENTORY QUANTITY (Ci)
U-234	0.002 wt%	43.8	6.2 E-03	0.272
U-235	0.215 wt%	4,712.8	2.2 E-06	0.010
U-236	0.003 wt%	65.8	6.5 E-05	0.004
U-238	99.78 wt%	2,187,178	3.4 E-07	0.744

(1) From 49 CFR 173.435

Table 5.2. Radiological Source Term for the 303-K/3707-G Building: 1.27 MT Natural Uranium and 0.47 MT Th.

RADIONUCLIDE	COMPOSITION	303K/3703 INVENTORY (g)	SPECIFIC ACTIVITY (Ci/g) ⁽¹⁾	INVENTORY QTY (Ci)
U-234	0.006 wt%	76.2	6.2E-03	0.472
U-235	0.72 wt%	9,144	2.2E-06	0.020
U-236	0.004 wt%	50.8	6.5E-05	0.003
U-238	99.27 wt%	1,260,729	3.4E-07	0.429
Th-232	100.00 wt%	470,000	1.1E-07	0.052

(1) from 49 CFR 173.435

Table 5.3 compares the summation of the 303-K/3707-G radionuclides with the Category 3 TQs (TQs are obtained from DOE 1992; the U-236 TQ was obtained from Mandigo 1996).

Table 5.3. Comparison of 303-K/3707-G Building Radiological Source Term with Category 3 Threshold Quantities

RADIONUCLIDE	303K/3703 INVENTORY (Ci)	CATEGORY 3 TQ QTY (Ci) ⁽¹⁾	INVENTORY QTY + CATEGORY 3 TQ
U-234	0.744	4.2	0.1771
U-235	0.030	4.2	0.0071
U-236	0.007	4.2 ⁽²⁾	0.0017
U-238	1.173	4.2	0.2793
Th-232	0.052	0.1	0.5200
Sum of Fractions			0.9852

(1) HNF-PRO-704, Table B-1.

(2) Mandigo 1996.

Because each radionuclide is less than the Category 3 TQ and the sum of fractions of the TQs is less than unity, the 303-K/3707-G is not a Nuclear Facility, per DOE-STD-1027-92.

HNF-PRO-704, *Hazard and Accident Analysis Process*, summarizes hazardous material inventory thresholds from DOE-EM-STD-5502-94, *Hazard Baseline Documentation* (DOE 1994), to guide the facility classification process. When the radiological threshold quantity (TQ) is less than the Hazard Category 3 TQ, but above the 40 CFR 302, Table 302.4, Appendix B reportable quantities (RQ), the facility is classified as Radiological. Table 5.4 compares the 303-K/3707-G radiological source term with the appropriate RQs from 40 CFR 302.

Table 5.4. Comparison of 303-K/3707-G Building Radiological Source Term with 40 CFR 302 Reportable Quantities

Radionuclide	Inventory Qty (Ci)	40 CFR 302 RQ (Ci) ⁽¹⁾	Exceeds 40 CFR 20 RQ
U-234	0.744	0.1	Yes
U-235	0.030	0.1	No
U-236	0.008	0.1	No
U-238	1.172	0.1	Yes
Th-232	0.052	0.001	Yes

(1) RQ values from 40 CFR 302, Table 302.4, Appendix B

Thus, the 303-K/3707-G Building radionuclide inventory exceeds the RQ values of 40 CFR 302 but is less than the Nuclear facility Hazard Category 3 TQ. Consideration of the uranium and thorium oxides as chemicals for comparison with the chemical RQs from 29 CFR 1910.119 and 40 CFR 302, Table 302.4, results in this facility being classified as a "low-hazard radiological" facility per HNF-PRO-704 since neither of these CFRs include uranium or thorium oxides in their listings of RQs.

5.2 303-E, 303-F, 333, 304, 303-M, 313-S, 334, 334-A and MO-052 Buildings

Each of these buildings has much less than the Nuclear Facility Category 3 threshold quantity of radionuclides, which corresponds to approximately 4 MT of the FSS uranium. Table 5.5 summarizes these building contents.

Table 5.5. Non-Fuel Storage Building Contents.

BUILDING	CONTENTS
303-E	Empty, fixed contamination
303-F/311-Tank Farm	Tanks (drained and cleaned)
303-M	Empty, ~40 kg U holdup in bag filters, fixed contamination
304	Empty, fixed contamination
313-S	Empty, fixed contamination, ~235 m ² contamination area
333	Offices, process equipment, estimated holdup: ~1.2 kg U, ~450 m ² contamination area
334 and Tank Farm	Empty, tanks empty & rinsed
334-A	Empty
MO-052 Trailer	Offices

Note: "Empty" signifies that inventories of fuel materials, hazardous materials, and equipment have been removed.

Determination of the hazard classification utilizes a process that examines facility radionuclide and other hazardous material contents to establish whether they are Radiological, Non-Nuclear, or Industrial facilities (HNF-PRO-704). This is done by comparing their radiological inventories with the reportable quantities (RQs) from 40 CFR 302, Table 302.4, Appendix B, and chemical inventories with the RQs from 40 CFR 302, Table 302.4. Radiological facilities possess radioactive material inventories which are less than the Nuclear facility Category 3 TQ, but more than the 40 CFR 302, Table 302.4, Appendix B Reportable Quantities (RQ). Non-Nuclear and Industrial facility radioactive material inventories are less than Table 302.4, Appendix B RQs, with the Non-Nuclear status assigned to facilities which possess RQs of non-radioactive hazardous substances. Industrial facilities have neither radioactive material nor hazardous substance in excess of RQs.

Comparison of the activities corresponding to the 303-M radionuclide inventory (40 kg) (DOE 1996) with the RQs of 40 CFR 302, Table 302.4, Appendix B is shown in Table 5.6 below:

Table 5.6. Comparison of 303-M Inventory with Radiological Facility RQs.

Radionuclide	Qty ⁽¹⁾ (g)	Activity (Ci)	RQ ⁽²⁾ (Ci)	Fraction RQ
U-234	4	0.0232	0.1	0.23
U-235	500	0.0011	0.1	0.011
U-236	28	0.0019	0.1	0.019
U-238	39,468	0.014	0.1	0.14
Tc-99	0.4	0.007	10	0.0007
Sum of Fractions				0.40

- (1) Composition conservatively presumed to be 1.25 wt% enriched; other radionuclide content identical to Table 2.0-1.
- (2) RQ values from 40 CFR 302, Table 302.4, Appendix B.

Since each of the radionuclides is less than their RQ and the sum of fractions is less than unity ($0.40 < 1$), the 303-M radionuclide content is less than the threshold for a Radiological facility. Inspection of Table 5.5 shows that no other facility has significant radionuclide inventory.

The other test is to compare the hazardous, non-radioactive substances with the RQs from 40 CFR 302, Table 302.4. There are no residual materials in the process equipment or stored materials that have RQs. Inspection of all these buildings has shown that no RQ of hazardous materials exists. Thus, all of these buildings are classified as Industrial facilities.

5.3 Anticipated Hazard Classification Reductions

Existing plans predict that all fuel materials stored at FSS will be removed before 2002. As the storage buildings are emptied, each will be downgraded from Nuclear Category 3 to Industrial. Documentation of DOE-RL confirmation that the inventory has been removed will provide justification for the downgrades.

6.0 REFERENCES

- DOE, 1992, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C.
- DOE, 1994, *Hazard Baseline Documentation*, DOE-EM-STD-5502-94, U.S. Department of Energy, Washington, D.C.
- DOE, 1996, Letter 96-TPD-196, J. E. Mecca to President, Westinghouse Hanford Company, *Westinghouse Request WR-F613 for Nuclear Material Transaction Authorization*, dated September 30, 1996
- HNF-PRO-704, *Hazard and Accident Analysis Process*, Project Hanford Management Contract, Richland, Washington.
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- 49 CFR *Transportation*, Part 173, Shippers - General Requirements for Shipments and Packaging, Section 435, October 1995.

Appendix A. 303-K/3707-D Building Inventory

DON'T SAY IT --- Write It!

DATE: March 26, 1997

TO: Record

FROM: Mark W. Benecke L6-26

Telephone: 376-0002

cc:

SUBJECT: 303-K/3703-D Inventory

Examination of the "Safeguards PRE Inventory Listing by MBA and Location, MBA 364", dated October 13, 1995, provides the following summary nuclear materials inventory information:

Depleted Uranium:	2,191,809 g
Normal Uranium:	1,266,463 g
Thorium:	469,507 g

This inventory is currently valid.

MW Benecke
MBA 364 Alternate Custodian