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Packaging Design Criteria, Transfer and Disposal of 102-AP Mixer Pump (WHC-SD-TP-PDC-026)		ECN No. -----

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7. Abstract A mixer pump installed in storage tank 241-AP-102 (102-AP) has failed. This pump is referred to as the 102-AP mixer pump (APMP). The APMP will be removed from 102-AP and a new pump will be installed. The main purpose of the Packaging Design Criteria (PDC) is to establish criteria necessary to design and fabricate a shipping container for the transfer and storage of the APMP from 102-AP. The PDC will be used as a guide to develop a Safety Evaluation for Packaging (SEP).		

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8. RELEASE STAMP

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EXECUTIVE SUMMARY

Radioactive waste material in storage tank 241-AP-102 (102-AP) has been periodically agitated by use of a mixer pump. This pump is referred to as the 102-AP Mixer Pump (APMP). The APMP is 60 ft long, 13,600 lb in weight, and powered by a 150 horsepower electric motor. This mixer pump has failed and requires removal from 102-AP.

The main purpose of this Packaging Design Criteria (PDC) is to establish criteria considered necessary to design and fabricate a shipping container for the transfer and disposal of the APMP from 102-AP.

The PDC will be used as a guide to develop a Safety Evaluation for Packaging (SEP). The SEP authorizes a onetime waste transfer and will be used to demonstrate that the onsite transfer of the waste package will provide an equivalent degree of safety¹ as would be provided by a package(s) meeting U.S. Department of Transportation (DOT) safety requirements. This fulfills onsite transportation safety requirements implemented by WHC-CM-2-14, *Hazardous Material Packaging and Shipping*.²

¹WHC, 1994, *Report on Equivalent Safety for Transportation and Packaging of Radioactive Materials*, WHC-SD-TP-RPT-001, Westinghouse Hanford Company, Richland, Washington.

²WHC-CM-2-14, *Hazardous Material Packaging and Shipping*, Westinghouse Hanford Company, Richland, Washington.

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LIST OF TERMS

AISC	American Institute of Steel Construction
APMP	102-AP Mixer Pump
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
CWC	Central Waste Complex
DOE	U.S. Department of Energy
EDE	effective dose equivalent
HEPA	high-efficiency particulate air (filter)
LLW	low-level waste
LST	lowest service temperature
NEPA	National Environmental Policy Act
PDC	Packaging Design Criteria
RAMPAC	Radioactive Materials Packaging
RMW	radioactive mixed waste
SDAR	Storage/Disposal Approval Record
SEP	Safety Evaluation for Packaging
TRU	transuranic
TSD	Treatment and Storage Disposal
WHC	Westinghouse Hanford Company

PACKAGING DESIGN CRITERIA TRANSFER AND DISPOSAL OF 102-AP MIXER PUMP

1.0 INTRODUCTION

1.1 BACKGROUND

Radioactive waste material in storage tank 241-AP-102 (102-AP) has been periodically agitated by use of a mixer pump. This pump is referred to as the 102-AP Mixer Pump (APMP). The APMP is 60 ft long, 13,600 lb in weight, and is powered by a 150 horse power electric motor. This mixer pump has failed and requires removal from 102-AP.

Equipment removed from 102-AP will be transferred to designated onsite locations for disposal depending on waste classification.

Classification of equipment as mixed or non-mixed waste is based on evaluating against the requirements of the "debris rule" (WHC 1993a). Presently, it is considered impractical to meet the performance objectives of the debris rule at the Tank Farms for non-mixed waste; hence, the removed equipment will be managed as mixed waste. Within 90 days, the mixed waste must be transferred from the Tank Farm to the Central Waste Complex (CWC) for interim storage pending evaluation for final disposition at a processing facility.

For clarification of terms used in this document, "packaging" refers to the assembly of components necessary to contain and transfer the radioactive waste equipment (i.e., APMP). The packaging may consist of a container, absorbent materials, thermal insulation, radiation shielding, and waste container cooling devices. "Package" refers to the combined packaging and radioactive contents (equipment).

1.2 PURPOSE AND SCOPE

The primary purpose of this Packaging Design Criteria (PDC) is to establish the packaging criteria considered necessary to design and fabricate an acceptable shipping container for the onsite transfer and storage of the APMP from 102-AP.

An additional purpose of the PDC is to provide information for the development of a Safety Evaluation for Packaging (SEP) and a Storage/Disposal Approval Record (SDAR). The SEP is required to authorize transfer of the waste package.

The scope of this PDC includes the development and/or identification of existing packaging criteria for both the onsite transfer and the interim storage and disposal of the equipment. The scope also includes analysis of package contents as required to determine the quantities of radioactive materials and classification of the waste.

1.3 JUSTIFICATION

Suitable packaging that can be used to transfer and store the large contaminated equipment for this project is not currently available; therefore, a new packaging must be designed and fabricated. This conclusion was based on packaging identified in WHC-SP-1070, *Radioactive Hazardous Material Packaging Directory* (WHC 1993b), a review of existing SARPs for onsite transfer, and a search using the Radioactive Materials Packaging (RAMPAC) Database to check available packaging at other U.S. Department of Energy (DOE) Sites.

2.0 WASTE PACKAGE CONTENTS

2.1 PHYSICAL DESCRIPTION

The contents of the packaging will consist of the APMP scheduled to be removed from the storage tank. The physical description and reference drawings for the mixer pump are as follows:

Maximum length:	60 ft		
Maximum diameter:	53 in.		
Estimated weight:	13,600 lb		
Reference drawings:	H-2-3146	H-2-76503	H-2-76504
	H-2-57331	H-2-57332	H-2-52963
	H-2-90562	H-2-90653	

2.2 CHEMICAL CONSTITUENT SOURCE TERM

The chemical constituents in tank 102-AP shall be chemically compatible with the APMP packaging materials. The tank 102-AP solution is maintained at pH 10 or higher to prevent corrosion of the carbon steel tank walls and would be judged compatible with a container fabricated of carbon steel.

2.3 WASTE INVENTORY

Analyses of radionuclide activities are provided in this section of the PDC to determine the estimated quantities of radioactive waste that will be transferred in the APMP package.

Table 1 shows the activity in curies for an estimated 1 mm thick film of waste tank material attached to specific internal ($5.34 \times 10^3 \text{ cm}^2$) and external ($2.1 \times 10^4 \text{ cm}^2$) areas of the APMP prior to rinsing and a liquid holdup of 95 gal ($3.60 \times 10^5 \text{ cm}^3$) inside the APMP. This is considered the "worst case" quantity of waste that may be attached to and contained inside the APMP. This waste quantity will be used throughout this PDC to assure that the packaging is acceptable for the intended transfer and storage of the equipment. Specific waste material data sheets used to develop the tables are shown in Appendix A.

Table 2 was developed to determine the effective A_2 values (10 CFR 51-199) for the mixture of radionuclides estimated to be attached to the APMP. In the case shown, the total estimated curies of waste material is greater than the calculated effective A_2 value indicating the APMP must be transferred as a Type B quantity of waste.

2.4 WASTE CLASSIFICATION

Two waste classifications are considered possible for transfer and disposal of the APMP. The specific waste classification assigned to the pump will be estimated prior to removal of the pump from the tank based on data presented in this section of the PDC. As noted in Section 1.1, cleaning equipment to the debris rule will not be attempted at the Tank Farm location and all equipment will be managed as mixed waste. Verification of the estimated waste classification, if required, will be provided by the waste generator prior to transfer of the equipment. The two possible waste classifications are as follows:

1. Mixed, Category 3, Low-Level Waste (LLW): Must be transferred within 90 days from the Tank Farm to a mixed waste controlled facility. Packages for storage of mixed waste must be provided with at least two containment barriers to prevent release of contamination. The package must have a 20 year service life and must be shielded to the storage facility requirements. Specific requirements for accepting the waste for interim storage shall be in accordance with the WHC-EP-0063-4, *Hanford Site Solid Waste Acceptance Criteria* (WHC 1993a).
2. Mixed Transuranic (TRU) Waste: Must be transferred within 90 days from the Tank Farm to a mixed waste controlled facility approved for acceptance of mixed-TRU waste. Packages for storage of mixed-TRU waste must be provided with at least two containment barriers to prevent release of contamination. The packages must have a 20 year service life and must be shielded to the storage facility requirements. Specific requirements for accepting the waste for interim storage shall be in accordance with WHC-EP-0063-4, *Hanford Site Solid Waste Acceptance Criteria* (WHC 1993a).

Table 1. Radionuclide Activity for 102-AP Mixer Pump.

Radionuclide	External Pump Film (Ci)*	Internal Pump Film and Holdup (Ci)**	Total Curies
^{14}C	1.11 E-05	1.93 E-04	2.04 E-04
^{99}Tc	1.88 E-03	3.27 E-02	3.46 E-02
^{129}I	7.79 E-07	1.36 E-05	1.44 E-05
^{63}Ni	2.63 E-07	4.57 E-06	4.83 E-06
^{90}Sr	3.09 E-02	5.37 E-01	5.68 E-01
^{90}Y	3.09 E-02	5.37 E-01	5.68 E-01
^{106}Ru	5.29 E-02	9.21 E-01	9.74 E-01
^{106}Rh	5.29 E-02	9.21 E-01	9.74 E-01
^{125}Sb	1.54 E-02	2.69 E-01	2.84 E-01
$^{125\text{m}}\text{Te}$	1.54 E-02	2.69 E-01	2.84 E-01
^{137}Cs	4.85 E+00	8.44 E+01	8.93 E+01
$^{137\text{m}}\text{Ba}$	4.59 E+00	7.99 E+01	8.45 E+01
^{144}Ce	2.86 E-02	4.97 E-01	5.26 E-01
^{144}Pr	2.86 E-02	4.97 E-01	5.26 E-01
^{238}Pu	3.42 E-06	5.96 E-05	6.30 E-05
^{239}Pu	1.56 E-06	2.72 E-05	2.88 E-05
^{240}Pu	1.56 E-06	2.72 E-05	2.88 E-05
^{241}Pu	8.82 E-05	1.53 E-03	1.62 E-03
^{241}Am	1.11 E-05	1.93 E-04	2.04 E-04
^{242}Am	1.11 E-05	1.93 E-04	2.04 E-04
^{237}Np	2.10 E-05	3.65 E-04	3.86 E-04
^{242}Cm	3.23 E-04	5.63 E-03	5.95 E-03
^{243}Cm	1.34 E-05	2.33 E-04	2.46 E-04
^{244}Cm	1.34 E-05	2.33 E-04	2.46 E-04

* Based on 1 mm film thickness of waste (2.1 E+04 cm³ film volume).

** Based on 1 mm film thickness of waste (5.34 E+03 cm³ film volume) and 95 gal of holdup (3.60 E+05 cm³).

Table 2. Effective A_2 -- 102-AP Mixer Pump.

Radionuclide	A_2 Limit (Ci)	APMP Ci	f_i	f_i/A_2
^{14}C	60	2.04 E-04	0	0
^{98}Tc	25	3.46 E-02	0.0002	0
^{129}I	2	1.44 E-05	0	0
^{63}Ni	100	4.83 E-06	0	0
^{90}Sr	0.4	5.68 E-01	0.0025	0.0063
^{90}Y	0.4	5.68 E-01	0.0025	0.0063
^{106}Ru	7	9.74 E-01	0.0043	0.0006
^{106}Rh	----	9.74 E-01	----	----
^{125}Sb	25	2.84 E-01	0.0012	0.0001
$^{125\text{m}}\text{Te}$	100	2.84 E-01	0.0012	0
^{137}Cs	10	8.93 E+01	0.3915	0.0392
$^{137\text{m}}\text{Ba}$	10	8.45 E+01	0.3704	0.0370
^{144}Ce	7	5.26 E+01	0.2306	0.0329
^{144}Pr	----	5.26 E+01	----	----
^{238}Pu	0.003	6.30 E-05	0	0
^{239}Pu	0.002	2.88 E-05	0	0
^{240}Pu	0.002	2.88 E-05	0	0
^{241}Pu	0.1	1.62 E-03	0	0
^{241}Am	0.008	2.04 E-04	0	0
^{242}Am	----	2.04 E-04	----	----
^{237}Np	0.005	3.86 E-04	0	0
^{242}Cm	0.2	5.95 E-03	0	0
^{243}Cm	0.009	2.46 E-04	0	0
^{244}Cm	0.01	2.46 E-04	0	0
TOTALS		228.12	1.00	0.1224
EFFECTIVE A_2				8.170

Note: The effective A_2 value is $1.00/0.1224 = 8.170$ Ci. The total curies are greater than the effective A_2 value; therefore, the APMP must be transferred as a Type B quantity of waste. The activity in the terms of A_2 is $228.12/8.170 = 27.92$.

The information summarized in Tables 3, 4, 5, and 6 was developed to estimate which of the above waste classifications(s) is applicable to the pump. This data is considered necessary to provide a firm basis for the design and fabrication of a shipping container that must be available prior to removal of the waste equipment from the tank.

Table 3 provides the limits on the number of curies permitted for Category 3, LLW. Table 4 indicates the weight of the waste and the pump. Table 5 lists the estimated amount of TRU material that will remain on the pump after removal from the tank. Table 3 limits are compared to the curie content of radionuclides estimated to remain on the pump (Table 1) to determine the category of the waste. Specific data sheets used to develop the tables and estimate the nanocuries per gram of the waste matrix are shown in Appendix A.

Comparison of waste matrix (equipment and waste material) activities shown in Tables 5 and 6, and the activity limits of radionuclides for Category 3, LLW shown in Table 3, indicate that:

- The total alpha activity (nanocuries per gram) of the waste matrix for all pieces of equipment is below the 100 nCi/g limit. Based on this data, the package contents are considered to be non-TRU waste prior to removal from the tank.
- The activity (curies per cubic meter) of the APMP is below the limits for Category 3, LLW per the sum of the fraction rule (WHC 1993a) specifying that the total of the radionuclide fractions must be less than 1.0. From WHC-EP-0063-4 (WHC 1993a), the volume considered for the Category 3 activity limits is based on the internal dimensions of the shipping container; however, since the design of the container is unknown, the volume used for these calculations will be conservatively assumed as the volume of the waste contents (APMP). Based on this data and worst case conditions, the package contents are considered to meet all the radionuclide requirements of Category 3, LLW.

For design of the shipping containers to meet disposal requirements, the mixer pump removed from 102-AP is considered to be non-TRU, mixed waste.

As noted earlier in this section, the estimated waste classifications(s) may be changed after removal of the equipment from the tank based on field verifications of the estimated waste classifications(s).

Table 3. Limit of Curies -- Category 3, Low-Level Waste.

Radionuclide	Activity Limits (Ci/m ³) Category 3	Radionuclide	Activity Limits (Ci/m ³) Category 3
³ H	5.0 E+06	¹⁸⁷ Re	1.1 E+03
¹⁰ Be	2.2 E+02	²⁰⁹ Po	7.7 E+01
¹⁴ C	9.1 E+00	²¹⁰ Pb	5.6 E+05
¹⁴ C*	9.1 E+01	²²⁶ Ra	3.6 E-02
³⁶ Cl	8.3 E-02	²²⁸ Ra	1.9 E+01
⁴⁰ K	3.4 E-01	²²⁷ Ac	3.2 E+05
⁶⁰ Co	7.7 E+01	²²⁸ Th	1.1 E-01
⁵⁹ Ni	8.3 E+02	²³⁰ Th	1.3 E-01
⁵⁹ Ni*	8.3 E+03	²³² Th	2.2 E-02
⁶³ Ni	1.7 E+04	²³¹ Pa	3.3 E-02
⁶³ Ni*	1.7 E+05	²³² U	4.0 E+00
⁷⁶ Se	8.3 E+01	²³³ U**	1.1 E+00
⁹⁰ Sr	1.5 E+04	²³⁴ U	2.1 E+00
⁹³ Zr	5.9 E+02	²³⁵ U	5.9 E-01
⁹⁴ Nb	5.6 E-02	²³⁶ U	2.2 E+00
⁹⁴ Nb*	5.6 E-01	²³⁸ U	1.4 E+00
⁹⁶ Mo	7.1 E+01	²³⁷ Np**	4.0 E-02
⁹⁹ Tc	1.2 E+00	²³⁸ Pu**	4.5 E+01
⁹⁹ Tc	1.2 E+00	²³⁹ Pu**	7.7 E-01
¹⁰⁷ Pd	1.0 E+03	²⁴⁰ Pu**	7.7 E-01
^{113m} Cd	2.0 E-01	²⁴¹ Pu**	3.1 E+01
^{121m} Sn	2.0 E+05	²⁴² Pu**	8.3 E-01
¹²⁶ Sn	1.8 E-04	²⁴⁴ Pu**	1.7 E-01
¹²⁹ I	5.9 E-01	²⁴¹ Am**	1.1 E+01
¹³³ B	7.7 E-01	²⁴² Am**	2.4 E+00
¹³⁵ Cs	4.2 E+01	²⁴³ Am**	2.8 E-01
¹³⁷ Cs	1.3 E+04	²⁴³ Cm**	6.3 E+02
¹⁴⁷ Sm	3.4 E+00	²⁴⁴ Cm**	2.9 E+02
¹⁵¹ Sm	1.8 E+05	²⁴⁵ Cm**	3.3 E-01
¹⁵⁰ Eu	7.7 E+02	²⁴⁶ Cm**	7.7 E-01
¹⁵² Eu	8.3 E-01	²⁴⁷ Cm**	1.5 E-01
¹⁵² Gd	1.3 E+03	²⁴⁸ Cm	2.0 E-01

* Limit for isotope in activated metal.

** Category 3 Limit is the lower of this value and 100 nCi/g.

Table 4. Total Weight of Waste Matrix.

Waste Equipment	Weight of Equipment	Internal Film Thickness Weight ($5.34 \text{ E}+03 \text{ cm}^3 \times 1.2 \text{ g/cm}^3$)	Pump Holdup Weight ($3.60 \text{ E}+05 \text{ cm}^3 \times 1.2 \text{ g/cm}^3$)	External Film Thickness Weight ($2.1 \text{ E}+04 \text{ cm}^3 \times 1.2 \text{ g/cm}^3$)	Total Weight of Waste Matrix
APMP Pump	13,600 lb	14	950	55	14,619 lb
	$6.174 \text{ E}+06 \text{ g}$	$6.408 \text{ E}+03 \text{ g}$	$4.113 \text{ E}+05 \text{ g}$	$2.520 \text{ E}+04 \text{ g}$	$6.637 \text{ E}+06 \text{ g}$

Table 5. 102-AP Mixer Pump Calculation -- Waste Matrix.

Radionuclide	APMP Ci	APMP nCi	TRU Concentration (nCi/g)
^{238}Pu	$6.30 \text{ E}-05$	$6.30 \text{ E}+04$	$9.49 \text{ E}-03$
^{239}Pu	$2.88 \text{ E}-05$	$2.88 \text{ E}+04$	$4.34 \text{ E}-03$
^{240}Pu	$2.88 \text{ E}-05$	$2.88 \text{ E}+04$	$4.34 \text{ E}-03$
^{241}Pu	$1.62 \text{ E}-03$	$1.62 \text{ E}+06$	$2.44 \text{ E}-01$
^{241}Am	$2.04 \text{ E}-04$	$2.04 \text{ E}+05$	$3.07 \text{ E}-02$
^{242}Am	$2.04 \text{ E}-04$	$2.04 \text{ E}+05$	$3.07 \text{ E}-02$
^{237}Np	$3.86 \text{ E}-04$	$3.86 \text{ E}+05$	$5.82 \text{ E}-02$
^{242}Cm	$5.85 \text{ E}-03$	$5.85 \text{ E}+06$	$8.81 \text{ E}-01$
^{243}Cm	$2.46 \text{ E}-04$	$2.46 \text{ E}+05$	$3.71 \text{ E}-02$
^{244}Cm	$2.46 \text{ E}-04$	$2.46 \text{ E}+05$	$3.71 \text{ E}-02$
TOTALS	$1.11 \text{ E}-02$	$1.11 \text{ E}+07$	1.337 nCi/g

Note: Weight of APMP used to calculate TRU concentration is $6.637 \text{ E}+06$.

Table 6. 102-AP Mixer Pump Category Calculation.

Radionuclide	APMP Waste (Ci)	Category 3 Limit (Ci/m ³)	Radionuclide Concentration (Ci/m ³)*	Fraction of Category 3 Limit
¹⁴ C	2.04 E-04	9.1 E+01	4.98 E-05	5.47 E-07
⁹⁹ Tc	3.46 E-02	1.2 E+00	8.43 E-03	7.03 E-03
¹²⁹ I	1.44 E-05	5.9 E-01	3.51 E-06	5.95 E-06
⁶³ Ni	4.83 E-06	1.7 E+05	1.18 E-06	6.94 E-12
⁹⁰ Sr	5.68 E-01	1.5 E+04	1.39 E-01	9.27 E-06
⁹⁰ Y	5.68 E-01	1.5 E+04	1.39 E-01	9.27 E-06
¹⁰⁶ Ru	9.74 E-01	NA	NA	NA
¹⁰⁶ Ru	9.74 E-01	NA	NA	NA
¹²⁵ Sb	2.84 E-01	NA	NA	NA
^{125m} Te	2.84 E-01	NA	NA	NA
¹³⁷ Cs	8.93 E+01	1.3 E+04	2.18 E+01	1.67 E-03
^{137m} Ba	8.45 E+01	NA	2.06 E+01	NA
¹⁴⁴ Ce	5.26 E-01	NA	NA	NA
¹⁴⁴ Pr	5.26 E-01	NA	NA	NA
²³⁸ Pu	6.30 E-05	4.5 E+01	1.54 E-05	3.42 E-07
²³⁹ Pu	2.88 E-05	7.7 E-01	7.02 E-06	9.12 E-06
²⁴⁰ Pu	2.88 E-05	7.7 E-01	7.02 E-06	9.12 E-06
²⁴¹ Pu	1.62 E-03	3.1 E+01	3.95 E-04	1.27 E-05
²⁴¹ Am	2.04 E-04	1.1 E+00	4.98 E-05	4.52 E-05
²⁴² Am	2.04 E-04	2.4 E+00	4.98 E-05	2.08 E-05
²³⁷ Np	3.86 E-04	4.0 E-02	9.41 E-05	2.35 E-03
²⁴² Cm	5.85 E-03	NA	1.42 E-03	NA
²⁴³ Cm	2.46 E-04	6.3 E+02	6.00 E-05	9.52 E-08
²⁴⁴ Cm	2.46 E-04	2.9 E+02	6.00 E-05	2.07 E-07
SUM OF FRACTIONS				0.0118

* Volume considered for Category 3 evaluation is conservatively assumed as 4.1 m³, the volume of the APMP, not the volume of the container.

2.5 FISSILE CLASS

Fissile materials present in the waste are ^{238}Pu , ^{239}Pu , and ^{241}Pu . The quantity (grams) of each component of fissile material is based on the total curies of each component divided by the specific activity of each component. Table 7 was developed to calculate the fissile contents of the waste in grams.

Table 7. Fissile Content.

	Activity (Ci/g)	Curies	Grams
^{238}Pu	17	6.30 E-05	3.70 E-06
^{239}Pu	0.62	2.88 E-05	4.65 E-05
^{241}Pu	110	1.62 E-03	1.47 E-05
TOTAL GRAMS			6.49 E-05

As shown in Table 7, the total grams of ^{238}Pu , ^{239}Pu , and ^{241}Pu estimated to be attached to the APMP is 6.49×10^{-5} g. Radioactive waste is exempted from fissile classification if the total quantity of fissile components is less than 15 g (49 CFR 100-177). Under the conditions stated above, the waste package containing the APMP will be considered as "fissile excepted."

3.0 FACILITY OPERATIONS

3.1 GENERATOR FACILITY

The APMP, scheduled for removal from tank 102-AP, will undergo several operations before placement into the waste shipping container. The upper section of the pump will be removed (unbolted). The pump, as it is removed from the tank, will undergo a high pressure spray operation within a plastic envelope. Basic steps for removing the APMP and placing into the waste shipping container are shown below:

1. The APMP shipping container will be placed in a special strongback and tilt assembly on a truck-trailer and then will be raised into the vertical position.
2. The upper section of the pump (approximately 13 ft) shall be removed (unbolted).

3. The APMP will be attached (hooked) to a portable flexible bag assembly installed on a spray wash assembly.
4. During removal from the tank by crane, the APMP will be sprayed by 3000 psi, 160 °F water.
5. After the APMP is fully raised into the flexible bag, the bottom section of the receiver bag will be remotely closed.
6. Using a crane, the APMP will be moved at a minimum possible elevation, then lifted approximately 75 ft, transferred over to the tilt assembly, and inserted into the shipping container.
7. The APMP shipping container will be lowered toward the horizontal position.
8. The APMP shipping container flanges will be installed to seal the open end.
9. The APMP shipping container will be lowered completely to the horizontal position and prepared for transfer.

3.2 DISPOSAL FACILITY

Waste equipment managed as mixed waste will be transferred within 90 days from the Tank Farm to the CWC for interim storage pending transfer to a processing facility for final disposition.

Specific waste package disposal requirements that are considered to impact development of packaging designs are included in Section 5.0 of this PDC.

4.0 PACKAGING/TRANSPORT SYSTEM DESIGN CRITERIA

4.1 GENERAL

The packaging and transport system shall be designed and constructed to transfer and provide containment for disposal of waste contents identified in Section 2.0 of this document. In particular, the packaging system shall be compatible with the use of the tilt assembly. The packaging and transport system designs shall also meet all applicable requirements of *Hazardous Material Packaging and Shipping* (WHC-CM-2-14) for onsite waste transfers and *Hanford Site Solid Waste Acceptance Criteria* (WHC 1993a) for disposal of the waste package. Provisions may be made to the packaging design to provide the ability to grout the interior of the package for "debris" rule treatment. In

addition, the packaging design shall provide sufficient support bearing area to meet floor loading requirements of the interim storage and processing facilities. For design purposes, the waste shall be consider mixed, non-TRU waste and shall be classified as "fissile excepted."

Design and fabrication of the APMP shipping container for onsite transfer of radioactive materials shall be based on American Society of Mechanical Engineers (ASME), Section VIII, for the containment boundary welds as a minimum. All other welds and structural components shall be designed and fabricated to American Welding Society (AWS) D1.1 and American Institute of Steel Construction (AISC) requirements, respectively.

If additional information is required to complete the packaging or transport systems, specific studies shall be performed by designated supporting organizations. Reference should be made to Section 5.0 of this PDC for specific transportation safety and disposal acceptance criteria that will govern approval of the packaging and transport system designs for this project. The design effort, in general, shall include the design of the shipping container and design of the shipping container tiedown system.

4.2 PACKAGING DESIGN CRITERIA

4.2.1 Construction Materials

Criteria for waste packaging construction materials shall be based on the following requirements for the transport and disposal of the package.

1. Packaging construction materials shall be selected to assure that there will be no significant chemical, galvanic, or other reaction among the package components or between the package components and the package contents, including possible reaction resulting from inleakage of water to the maximum credible extent during the specified lifetime of the packaging. Existing Westinghouse Hanford Company (WHC) procedures require that material in underground storage tanks be maintained at 10 pH or higher for compatibility with the carbon steel tanks. Under these conditions, the use of carbon steel for packaging structural components to contain and transfer equipment removed from underground storage tanks is consider acceptable.
2. Material structural properties shall conform to packaging structural design analysis for the safe transfer, unloading, and disposal of the waste package under the conditions described in this document.
3. Selection of material to assure that brittle fracture is unlikely to occur during onsite transfers shall be based on guidelines listed in Table 6 of NUREG/CR-1815. The level of safety using

these guidelines assures that the fracture toughness is sufficient to prevent fracture initiation at minor defects typical of good fabrication practices specified in the NUREG guidelines. The lowest service temperature (LST) for design purposes shall be -10 °F.

4.2.2 Packaging Dimensions

The APMP shipping container shall be sized to transfer and contain for storage the equipment described in Section 2.0 of this document. The internal diameter of the APMP shipping container shall include suitable clearances for insertion of the APMP and the flexible bag.

4.2.3 Weight of Contents

The waste packaging shall be capable of carrying the maximum weight of the designated payload. The weight of the contents is 14,619 lb (Table 4).

4.2.4 Maximum Gross Weight

The maximum gross weight of the package for design purposes shall include the estimated maximum amount of shielding that may be installed to meet dose rate requirements for transfer and storage of the package.

4.2.5 Venting

Fittings shall be provided on the packaging to provide venting of the waste package. Positive closure devices shall be provided on the fittings if venting is not required for transfer or disposal. The size and location of the fittings shall be based on support studies to determine the potential gas generation rates and venting requirements for the specific waste contents of the package (see Section 5.1.5). In addition, approved high-efficiency particulate air (HEPA) filter shall be provided as part of the packaging design.

4.2.6 Lifting Attachments

Attachments shall be provided on the shipping container, as required, to safely lift the waste package and secure the waste package during transfer. Any lifting attachment that is a structural part of the package shall be designed with one of the following (whichever is more conservative):

- A minimum safety factor of 3 against yielding.
- A safety factor of 5 based on the ultimate strength of the material. When the lifting attachment is used as intended, it must be designed so that a lifting device failure caused by an excessive load will not impair the package from meeting other criteria. Any structural part of the package not approved for

lifting the package shall be rendered inoperable for lifting the package during transfer or shall be designed with strength equivalent to that required for the approved lifting attachments.

4.2.7 Tiedown Attachments

Tiedown devices that are attached to the packaging shall be capable of holding the package on the transport trailer during sudden stops and cornering speeds of 15 mph without exceeding the yield strength of the tiedown device or its connection point to the package. In addition, tiedown devices that are a structural part of the package must be capable of withstanding, without generating stress in any material of the package in excess of its yield strength, a static force applied to the center of gravity of the package having a vertical component of two times the weight of the package with its contents, a horizontal component along the direction in which the vehicle travels of ten times the weight of the package with its contents, and a horizontal component in the transverse direction of five times the weight of the package with its contents. Any other structural part of the package which could be used to tiedown the package shall be rendered inoperable for tying down the package during transport, or shall be designed with strength equivalent to that required for tiedown devices. Each tiedown device, which is a structural part of a package, must be designed so that failure of the device under excessive load would not impair the ability of the package to meet other requirements of this section.

4.2.8 Closure Design

The packaging shall have a positive closure device that cannot be opened unintentionally and will keep the closure in place after a vehicle rollover and impact of the packaging on soft soil. The closure system shall provide for remote closure, if required, with guides allowing remote lid positioning.

4.2.9 Containment

The packaging design shall include one approved containment barrier for onsite transfer of the package. In addition, the packaging design shall include a second containment barrier for storage/disposal of the package. The second containment barrier shall be approved by the storage facilities. Double containment shall be provided for the sides and ends of the package. The flexible bag shall not be considered as a containment barrier. The packaging design shall accommodate the addition of absorbent materials for absorption of any liquids within the package.

4.2.10 Service Life

For purposes of packaging design and storage, the packaging shall be designed for a minimum of a 20 year service life in the CWC (WHC 1993a).

4.2.11 Decontamination

The packaging, if practical, should have a minimum amount of crevices, joints, and rough edges that would jeopardize effective decontamination. For shipping container design purposes, removable contamination on the exterior surfaces of the waste package for transfer and storage shall not exceed the following limits:

Nuclide (note 1)	Removable (dpm/100 cm ²) (note 2)	Total (Fixed + Removable) (dpm/100 cm ²) (note 3)
U-natural, ²³⁵ U, ²³⁸ U, and associated decay products.	220 alpha	5,000 alpha
Transuranics, ²²⁶ Ra, ²²⁸ Ra, ²³⁰ Th, ²²⁸ Th, ²³¹ Pa, ²²⁷ Ac, ¹²⁵ I, ¹²⁹ I	20	500
Th-nat, ²³² Th, ⁹⁰ Sr, ²²³ Ra, ²²⁴ Ra, ²³² U, ¹²⁶ I, ¹³¹ I, ¹³³ I	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above. Includes mixed fission products containing ⁹⁰ Sr.	1,000 beta/gamma	5,000 beta/gamma
Table notes: 1. The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item. Where contamination by both alpha-and beta/gamma-emitting nuclides exists, the limits established for the alpha-and beta/gamma-emitting nuclides apply independently. 2. The amount of removable radioactive material per 100 cm ² of surface area should be determined by swiping the area with dry filter or soft absorbent paper, while applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm ² , the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranic elements, ²²⁶ Ra, ²²⁷ Ac, ²²⁸ Th, ²³⁰ Th, ²³¹ Pa, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination. 3. The levels may be averaged over 1 m ² provided the maximum activity in any area of 100 cm ² is less than three times the values in the table.		

4.2.12 Shielding

Provisions shall be provided on the packaging for installing shielding to limit the maximum dose rate at the surface of the package to 100 mrem/h (see Section 5.2.1) or less for interim storage of the package at the CWC. The shielding shall be sufficient to accommodate the projected film thickness of radioactive material on the internal and external pump surfaces (1 mm film thickness) and "worst case" liquid holdup inside the pump of 95 gal. The shielding may be installed, as directed, during packaging construction or in the field prior to package transfer. The effect of the APMP decontamination procedure may be considered for the amount of shielding added to the package in the field. In either case, design analysis shall be provided to assure that the packaging is structurally safe for loading, transfer, and unloading a fully shielded package. The estimated maximum shielding thickness and required location of shielding on the package shall be determined from waste activity data provided in Section 2.0.

4.3 TRANSPORT SYSTEM

4.3.1 General

A transport trailer assembly shall be used and shall be capable of transferring the maximum size and maximum weight of the APMP waste package.

Specific design and/or specifications for the transport system shall include considerations of the waste package as described in Section 3.0 of this document.

4.3.2 Tiedowns

The tiedown assemblies used to secure the package to the transport vehicle shall be designed and evaluated to assure that the tiedown assemblies used to secure the package against movement in any direction have the aggregate static breaking strength of at least $1\frac{1}{2}$ times the weight of the package. Design and analysis of the tiedown system shall be provided as part of the packaging design project and will be included as part of the SEP documentation.

4.3.3 Speed Restrictions

The speed of the transport trailer shall not exceed 35 mph on straight sections of the road and 15 mph on curved sections of the road during waste transfer.

4.3.4 Shielding

Acceptable maximum dose limits for onsite waste transfer shall be 1000 mrem/h at the surface of the package, 200 mrem/h at any point on the outer surface of the vehicle, 10 mrem/h at 2 m from the trailer, and 2 mrem/h (WHC-CM-1-6, *WHC Radiological Control Manual*) at any space normally occupied by personnel.

5.0 GENERAL REQUIREMENTS

The waste packaging and transportation concepts described in this PDC involve the design and fabrication of new packagings (waste containers). Development and use of new packaging components requires that a safety analysis, criticality analysis, and risk analysis be applied to assure that all anticipated events are addressed.

Safety of onsite transfers using the new waste packaging will be based on providing an equivalent degree of design and safety analysis as would be provided by a package shipped in commerce. This equivalent degree of design

and safety analysis will be provided in the SEP documentation required to authorize onsite transfer of the waste package for this project. The SEP will be developed and issued by Packaging Safety Engineering. Authorization for disposal of the package will be provided by a SDAR. The SDAR will be developed and issued by the Acceptance Services Group.

A combination of packaging design analysis and risk assessment will be employed in the SEP evaluation process. The SEP analysis will demonstrate the ability of the packaging to provide containment for normal transfer conditions and, if required, for credible accidents.

The following information should be used as a basis for development of the SEP and SDAR documentation.

5.1 TRANSPORTATION SAFETY

5.1.1 Normal Conditions of Transfer

To assure that the APMP package is adequate to withstand normal onsite transfer conditions, a simulated drop of the package from a horizontal position shall be evaluated. The evaluation shall verify that material stresses will not exceed yield stresses at critical structural or closure locations following a simulated drop onto a 12 in. thick reinforced concrete slab. Reinforcing of the slab shall be considered to be #9 rebar at 12 in. spacings. In the event that the package may be transferred without shielding, the drop test analysis shall consider both the shielded and unshielded packages. The package (including contents) shall be analyzed for the drop test based on the following criteria (10 CFR 51-99):

- Packages weighing 11,000 lb or less shall be analyzed for a 4 ft drop.
- Packages weighing from 11,000 to 22,000 lb shall be analyzed for a 3 ft drop.
- Packages weighing from 22,000 to 33,000 lb shall be analyzed for a 2 ft drop.
- Packages weighing in excess of 33,000 lb shall be analyzed for a 1 ft drop.

Normal vibration of the package during transfer shall be evaluated to assure that the package is capable of withstanding the expected movements.

The packaging shall be evaluated to determine the effects of a reduction in external pressure to 3.5 psi absolute and an increase in external pressure to 20 psi absolute. Evaluations in the SEP shall consider the need for positive and/or vacuum pressure testing of the packaging based on results of

the gas generation support study. If pressure testing is required, specific design pressure ratings of the packaging shall be established. These design pressure ratings shall meet the requirements for both the transfer and long-term interim storage of the package.

A penetration test shall be performed on the package to determine the effects of the hemispherical end of a vertical steel cylinder of 3.2 cm diameter and 6 kg mass dropped from a height of 1 m. The steel cylinder shall be dropped onto the exposed surface of the package which is expected to be most vulnerable to penetration. The long axis of the cylinder must be perpendicular to the package surface.

Testing and evaluations for normal conditions of onsite transfers shall consider the effects of transferring a package at ambient temperatures between -10 °F and 115 °F.

5.1.2 Accident Conditions

The waste package shall be capable of retaining the contents of the package and limiting direct radiation to acceptable levels for unplanned events during transfer. Evaluations of the unplanned events shall be performed and included in the SEP to demonstrate that the waste package meets the following criteria:

- A. Incredible Events: Any event that has a probability less than 10^{-6} per year is considered incredible. The administrative limit for radiation exposure to individuals offsite is 25 rem [effective dose equivalent (EDE)] for accident events which are in the order of 10^{-7} to 10^{-6} in annual frequency.
- B. Credible Events: Any unplanned event that has a probability between 10^{-6} and 10^{-3} per year shall not lead to a radiation exposure of greater than 5000 mrem to any Site worker, or 500 mrem to any member of the public. These unplanned events are considered credible.
- C. Probable Events: An unplanned event that has a probability greater than 10^{-3} per year shall not lead to a radiation exposure of greater than 200 mrem to a Site worker or 10 mrem to a member of the public. Any unplanned event where the probability cannot be determined shall be considered greater than 10^{-3} per year and probable.

5.1.3 Accident Frequency Analysis

An analysis shall be performed to determine the estimated annual accident frequency for the transfer of radioactive material described in this PDC. Results of the analysis shall be evaluated based on criteria presented in Section 5.1.2 of this PDC to determine the extent of unplanned events that

should be considered for the safe transfer of the radioactive materials. In addition, if mileage restrictions apply to the package for calculated unplanned events in the analysis, these restrictions shall be identified for evaluation in the SEP.

5.1.4 Dose Consequence Analysis

A dose consequence analysis of the proposed methods for transferring the package from the AP Tank Farm to the disposal site shall be performed and included in the SEP documentation. The analysis shall include a specific mitigated loss of contents from the package during transfer to the storage/disposal site. Results of this analysis shall indicate if the consequence resulting from potential loss of the contents are acceptable or not acceptable in accordance with criteria presented in Section 5.1.2

5.1.5 Venting

The package should not incorporate any feature that allows continuous venting during onsite transfers. If continuous venting is considered necessary during transfers based on gas generation studies, the SEP shall include an analysis demonstrating that an equivalent degree of safety is provided. As a minimum, the packaging shall be vented through an approved HEPA filter. If venting is not required during transfer, the SEP shall provide operational controls to ensure that the vents are closed during transfer with suitable closure devices.

5.1.6 Shielding

Shielding analysis shall be provided in the SEP to assure that the estimated shielding for the packaging design is sufficient to safely maintain the dose rates to onsite personnel to the limits of this PDC. In addition, shielding analysis shall verify that dose rate limits at the edge of the transport vehicle and driver location are not exceeded.

5.1.7 Thermal

Internal heat generation of the waste shall not prevent the package from maintaining containment and shielding as defined by the criteria in this PDC.

5.2 PACKAGE DISPOSAL

Waste packages shall be acceptable for storage of mixed waste at a designated Treatment Storage and Disposal (TSD) Facility in accordance with *Hanford Site Solid Waste Acceptance Criteria* (WHC 1993a). Provisions may be made to the packaging design to provide the ability to grout the interior of the package for "debris rule" treatment. If the waste package is determined to meet the requirements of the Solid Waste Acceptance Criteria, formal approval will be documented by the issue of a SDAR by the TSD Facility. Based

on analysis presented in Section 2.0 of this PDC, the waste contents will be considered to be non-TRU, mixed waste prior to removal from the tank. Verification of the actual waste classification shall be provided, if required, by the waste generator prior to transfer.

The package disposal requirements listed in this section of the PDC are included as a guide for packaging design and are not intended to replace formal package acceptance criteria and are subject to change based on possible conflicts with, or revision to, formal solid waste acceptance documentation. It is considered the responsibility of the packaging design personnel to work closely with TSD personnel to assure that packaging is designed to meet requirements applicable at the expected time of disposal of the waste package.

5.2.1 Shielding

Dose rates for contact handled package transferred to a TSD Facility approved for storage of mixed waste at the CWC may not exceed 100 mrem/h (WHC 1993a).

5.2.2 Containment

The waste package shall provide at least two containment barriers, or as specified in the applicable SDAR, to prevent the release of contamination. The containment barriers shall be designed for 20 year service (WHC 1993a).

5.2.3 Thermal Power

Internal heat generation of the waste package should not prevent the container from maintaining its integrity during the specified lifetime of the waste package. In addition, any package with the potential to generate greater than 0.1 W/ft^3 (WHC 1993a) should have acceptance criteria included in the SDAR.

5.2.4 Gas Generation

Packages of radioactive mixed waste (RMW), with the potential for gas generation or the potential to reach explosive concentrations of hydrogen and oxygen or other explosive gases, require vents or catalyst packs to deplete free oxygen and prevent explosive concentrations. Vents shall be sized to ensure adequate passage of generated gas.

5.2.5 Materials

All packages used for the storage of RMW must be constructed of metal or other noncombustible material. Additional materials must be consistent with TSD Facility fire code requirements.

5.2.6 Handling

Crane unloaded packages shall be equipped with lifting devices designed to safely lift the fully loaded package. All lifting attachments shall be designed with a 5:1 safety factor based on ultimate strength of the materials, or a 3:1 safety factor based on the yield strength of the materials, whichever is more conservative. The package itself shall be designed with a 2:1 safety factor based on the yield strength of the packaging fabrication materials.

5.3 ALARA

Design features of the packaging shall be consistent with the requirements in WHC-CM-4-11, *ALARA Program Manual*. Exposure of personnel to radiological and other hazardous materials associated with the loading, closure, and offloading of the package shall be minimized.

5.4 QUALITY ASSURANCE

Design, construction, testing, and verification activities for the shipping container shall be in accordance with the *Quality Assurance Manual*, WHC-CM-4-2. Procurement of packaging materials, fabrication, and inspection/testing activities shall be developed based on requirements listed in this PDC and other applicable documents. All inspections and testing shall be documented.

The approval designators and approval requirements for documentation associated with the analysis, design, and fabrication of the shipping container and components shall be in accordance with *Document Control and Records Management Manual*, WHC-CM-3-5. Based on a dose consequence analysis (Appendix B) conducted on the radioactive inventory levels listed in Section 2.0, the safety class of the shipping container and components shall be assigned Safety Class 3 in accordance with *Management Requirements and Procedures* (MRP) 5.46 (WHC-CM-1-3).

5.5 SAFETY

Documentation and analysis of safety requirements for the onsite transfer and storage of the shipping container shall be provided by development of a SEP and shall be in accordance with MRP 5.20 (WHC-CM-1-3). Based on the activity levels listed in Section 2.0, the SEP shall be assigned an approval designator of SQ in accordance with WHC-CM-3-5. Safety assessments required to assure the safe loading and unloading the waste package onto or from the transfer vehicle shall be provided by the operating facilities performing the loading and unloading procedures.

5.6 PACKAGING AND SHIPPING

General requirements for the packaging and shipping of hazardous radioactive materials shall be in accordance with WHC-CM-2-14.

5.7 DESIGN FORMAT

Design, design changes, and design documentation shall be in accordance with DOE Order 6430.1A (*General Design Criteria*), *Standard Engineering Practices* (WHC-CM-6-1), and *Drafting Standards* (WHC-CM-6-3).

5.8 ENVIRONMENTAL COMPLIANCE

Actions/conditions for protecting the environment during transportation of the waste equipment shall comply with requirements in *Environmental Compliance*, WHC-CM-7-5. Any spills, venting, or other unplanned releases will be responded to under existing contingency/response and reporting plans. Environmental documentation, as required under the National Environmental Policy Act (NEPA), will be coordinated through the WHC "Regulatory Support/NEPA Evaluation and Permitting."

5.9 MAINTENANCE

Ease and minimization of maintenance shall be considered in the design of the shipping container. Vendor spare parts and maintenance data, if applicable, shall be provided for equipment specified in the design. Special tools required to operate and/or replace/repair components shall be provided as part of the project.

6.0 REFERENCES

10 CFR 51-199, "Packaging and Transportation of Radioactive Materials," *Code of Federal Regulations*, as amended.

49 CFR 100-177, "Packaging and Transportation of Radioactive Materials," *Code of Federal Regulations*, as amended.

DOE, 1989, *General Design Criteria*, DOE 6430.1A, U.S. Department of Energy, Washington, D.C.

- Holman, W. R., and R. T. Langland, 1981, *Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Container Up to Four Inches Thick*, NUREG/CR-1815, (under Lawrence Livermore National Laboratory contract to the NRC), U.S. Nuclear Regulatory Commission, Washington, D.C., August 1981.
- RL, 1982, "Safety Requirements for the Packaging of Fissile and Other Radioactive Material," *Environmental Protection, Safety, and Health Protection Program for RL*, RL 5480.1, Change 1, Chapter III, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- WHC-CM-1-3, *Management Requirements and Procedures*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-1-6, *WHC Radiological Control Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-2-14, *Hazardous Material Packaging and Shipping*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-3-5, *Document Control and Records Management Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-4-2, *Quality Assurance Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-4-3, *Industrial Safety Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-4-11, *ALARA Program Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-4-29, *Nuclear Criticality Safety Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-4-40, *Industrial Hygiene Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-4-1, *Fire Protection Program Manual*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-6-1, *Standard Engineering Practices*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-6-3, *Drafting Standards*, Westinghouse Hanford Company, Richland, Washington.
- WHC-CM-7-5, *Environmental Compliance*, Westinghouse Hanford Company, Richland, Washington.

- WHC, 1993a, *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-4, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1993b, *Radioactive Hazardous Material Packaging Directory*, WHC-SP-1070, Westinghouse Hanford Company, Richland, Washington.
- WHC, 1994a, *Report on Equivalent Safety for Transportation and Packaging of Radioactive Materials*, WHC-SD-TP-RPT-001, Westinghouse Hanford Company, Richland, Washington, January, 1994.
- WHC, 1994b, *Work Plan - AP-102 Mixer Pump Removal and Pump Replacement*, WHC-SD-WP-283, Westinghouse Hanford Company, Richland, Washington, September, 1994.

APPENDIX A.

TANK 102-AP PUMP SOURCE TERM.

**Westinghouse
Hanford Company****Internal
Memo**

From: Radiation Physics and Shielding
Phone: 376-3765 H0-35
Date: October 5, 1994
Subject: TANK 102-AP PUMP SOURCE TERM

22570-HJG-94-028

To: Karl Hillesland

H4-64

cc: Jess Greenborg H0-35
Greg Field G2-02
Brit Hey H4-64
James Daughtry H4-64
Rafael Jimenez S4-43
Richard Carlstrom G2-02
Craig Shaw L5-07
HJG File/LB

The following is an estimate of the worst case and average case for the source term for the liquid holdup in the 102-AP mixer pump. The isotopic concentrations were taken from *Tank 241-AP-102 Characterization and Grout Product Test Results* (WHC-SD-WM-TRP-168, Rev.0).

The volumetric estimates represent the results of our discussion of 20 September 1994. The volute, modeled as a disc 30" in diameter and 4" thick, the the cooling annulus, assumed to be a torus 12" high with a 20" inner diameter and a 30" outer diameter, and the connecting volumes between these two are assumed to be completely drained of liquid. The pump was designed and fabricated to be completely self draining. There are drain holes drilled in the volute low points and in the impeller in addition to the suction eye.

The motor shroud will hold about $3.60 \times 10^5 \text{ cm}^3$ (95 gallons). While this volume is generally sealed off, the presence of threaded feedthroughs for the electrical connections on the upper and lower halves of the shroud allows for a path. A similar pump immersed in water for a week or so had about a pint of water in this area. In our case, despite the probability that "gunk" would quickly seal up these leakage paths, we cannot guarantee that this volume would not fill up over the years that the pump has been in the tank.

The average case envisions that a 1mm film of liquid remains on all of the interior surfaces. The volute, with two 30" diameter discs had 9.8 ft^2 , the impeller, with four 19" discs had 7.9 ft^2 , and the annulus has 18.5 ft^2 . In addition, 20% of this total was added to account for nozzles, impeller vanes, etc. Finally, the connecting volume between the cooling annulus and the volute adds another $1.30 \times 10^4 \text{ cm}^2$ (14 ft^2) to the total. Thus, the total internal surface area was estimated to be $5.34 \times 10^4 \text{ cm}^2$ (47.5 ft^2). Note that this total does not include the motor shroud.

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If we assume a 1mm thick film, the most likely internally entrained liquid volume is estimated to be $5.34 \times 10^5 \text{ cm}^3$. This volume was added to the worst case also since these surfaces will be wetted in this case also.

102-AP Pump Internal Source Term			
Isotope		Worst Case	Average Case
	Ci/cm ³	Ci	Ci
¹⁴ C	5.280e-10	1.93e-04	2.82e-06
⁹⁹ Tc	8.940e-08	3.27e-02	4.77e-04
¹²⁹ I	3.710e-11	1.36e-05	1.98e-07
⁶³ Ni	1.250e-11	4.57e-06	6.68e-08
⁹⁰ Sr	1.470e-06	5.37e-01	7.85e-03
⁹⁰ Y	1.470e-06	5.37e-01	7.85e-03
¹⁰⁶ Ru	2.520e-06	9.21e-01	1.35e-02
¹⁰⁶ Rh	2.520e-06	9.21e-01	1.35e-02
¹²⁵ Sb	7.350e-07	2.69e-01	3.92e-03
^{125m} Te	7.350e-07	2.69e-01	3.92e-03
¹³⁷ Cs	2.310e-04	8.44e+01	1.23e+00
^{137m} Ba	2.188e-04	7.99e+01	1.17e+00
¹⁴⁴ Ce	1.360e-06	4.97e-01	7.26e-03
¹⁴⁴ Pr	1.360e-06	4.97e-01	7.26e-03
²³⁸ Pu	1.630e-10	5.96e+05	8.70e-07
^{239/240} Pu	7.440e-11	2.72e-05	3.97e-07
²⁴¹ Pu	4.200e-09	1.53e-03	2.24e-05
^{241/242} Am	5.270e-10	1.93e-04	2.81e-06
²³⁷ Np	1.000e-09	3.65e-04	5.34e-06
²⁴² Cm	1.540e-08	5.63e-03	8.22e-05
^{243/244} Cm	6.370e-10	2.33e-04	3.40e-06

In addition to the internal liquid holdup, it is estimated that there will be a 1mm film of liquid on the external surfaces. You have told me that in your model, assuming that the pump extends 34 ft below the surface of the waste, that there will be $2.1 \times 10^5 \text{ cm}^2$ of wetted surface area which, with a 1mm film will lead to a $2.1 \times 10^4 \text{ cm}^3$ volume of liquid on the outside surfaces of the pump.

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102-AP Pump External Source Term		
	Ci/cm ³	Ci
¹⁴ C	5.280e-10	1.11e-05
⁹⁹ Tc	8.940e-08	1.88e-03
¹²⁹ I	3.710e-11	7.79e-07
⁶³ Ni	1.250e-11	2.63e-07
⁹⁰ Sr	1.470e-06	3.09e-02
⁹⁰ Y	1.470e-06	3.09e-02
¹⁰⁶ Ru	2.520e-06	5.29e-02
¹⁰⁶ Rh	2.520e-06	5.29e-02
¹²⁵ Sb	7.350e-07	1.54e-02
^{125m} Te	7.350e-07	1.54e-02
¹³⁷ Cs	2.310e-04	4.85e+00
^{137m} Ba	2.188e-04	4.59e+00
¹⁴⁴ Ce	1.360e-06	2.86e-02
¹⁴⁴ Pr	1.360e-06	2.86e-02
²³⁸ Pu	1.630e-10	3.42e-06
^{239/240} Pu	7.440e-11	1.56e-06
²⁴¹ Pu	4.200e-09	8.82e-05
^{241/242} Am	5.270e-10	1.11e-05
²³⁷ Np	1.000e-09	2.10e-05
²⁴² Cm	1.540e-08	3.23e-04
^{243/244} Cm	6.370e-10	1.34e-05

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These should be sufficient to act as the source terms for accident dose consequence and for shielding calculations. In the case of double isotopes with one activity, the worst case should be chosen for the particular situation. I would suggest that for shielding calculations, ISOSHL be used so that the bremsstrahlung contribution to the dose will be included.

If the estimations of the holdup are refined further, the spreadsheet is easily changed. Please get ahold of me in this case so that we don't have several source terms floating about.

Harvey Goldberg
Principal Engineer

CONCURRENCE:

Jess Greenberg, Manager
Radiation Physics and Shielding

102-AP Pump Internal Source Term				102-AP Pump External Source Term 34 ft			
		Worst Case CI	Average Case CI		CI/cc	CI	
C-14	5.280E-10	1.93E-04	2.82E-06	C-14	5.280E-10	1.11E-05	
Tc-99	8.940E-08	3.27E-02	4.77E-04	Tc-99	8.940E-08	1.88E-03	
I-129	3.710E-11	1.36E-05	1.98E-07	I-129	3.710E-11	7.79E-07	
Ni-63	1.250E-11	4.57E-06	6.66E-08	Ni-63	1.250E-11	2.63E-07	
Sr-90	1.470E-06	5.37E-01	7.85E-03	Sr-90	1.470E-06	3.09E-02	
Y-90	1.470E-06	5.37E-01	7.85E-03	Y-90	1.470E-06	3.09E-02	
Ru-105	2.520E-06	9.21E-01	1.35E-02	Ru-105	2.520E-06	5.29E-02	
Rh-106	2.520E-06	9.21E-01	1.35E-02	Rh-106	2.520E-06	5.29E-02	
Sb-125	7.350E-07	2.69E-01	3.92E-03	Sb-125	7.350E-07	1.54E-02	
Te125m	7.350E-07	2.69E-01	3.92E-03	Te125m	7.350E-07	1.54E-02	
Cs-137	2.310E-04	8.44E+01	1.23E+00	Cs-137	2.310E-04	4.85E+00	
Ba-137m	2.188E-04	7.99E+01	1.17E+00	Ba-137m	2.188E-04	4.59E+00	
Ce-144	1.360E-06	4.97E-01	7.26E-03	Ce-144	1.360E-06	2.86E-02	
Pr-144	1.360E-06	4.97E-01	7.26E-03	Pr-144	1.360E-06	2.86E-02	
Pu-238	1.630E-10	5.96E-05	8.70E-07	Pu-238	1.630E-10	3.42E-06	
Pu-239/240	7.440E-11	2.72E-05	3.97E-07	Pu-239/2	7.440E-11	1.56E-06	
Pu-241	4.200E-09	1.53E-03	2.24E-05	Pu-241	4.200E-09	8.82E-05	
Am-241/242	5.270E-10	1.93E-04	2.81E-06	Am-241/2	5.270E-10	1.11E-05	
Np-237	1.000E-09	3.85E-04	5.34E-06	Np-237	1.000E-09	2.10E-05	
Cm-242	1.540E-08	5.63E-03	8.22E-05	Cm-242	1.540E-08	3.23E-04	
Cm-243/244	6.370E-10	2.33E-04	3.40E-08	Cm-243/2	6.370E-10	1.34E-05	

APPENDIX B.

SAFETY CLASS ANALYSIS FOR THE TANK 102-AP PUMP.

**Westinghouse
Hanford Company****Internal
Memo**

From: Radiation Physics and Shielding
Phone: 376-3765 H0-35
Date: November 2, 1994
Subject: SAFETY CLASS ANALYSIS FOR THE TANK 102-AP PUMP

8D530-HJG-95-002

To: Richard Carlstrom G2-02

cc: Jess Greenborg H0-35
Greg Field G2-02
Brit Hey H4-64
James Daughtry H4-64
Rafael Jimenez S4-43
Karl Hillesland H4-64
Craig Shaw L5-07
HJG File/LB

A pump is to be removed and a shipping container is being designed to transport it. This analysis is for the purpose of determining the safety class of the proposed shipping container. The contents of the container is assumed to be completely available for release. The offsite receptor is positioned at the site boundary and near bank of the river while the onsite receptor is 100 m from the release. The integrated concentration, in sec/m^3 , used is the value that is not exceeded more than 0.5% of the time in all releases for the particular site.

The isotopic concentrations were initially taken from *Tank 241-AP-102 Characterization and Grout Product Test Results* (WHC-SD-WM-TRP-168, Rev.0). The methodology and results for developing the source term for this particular situation are outlined in internal memo 22570-HJG-94-028, *TANK 102-AP PUMP SOURCE TERM*, from H. J. Goldberg to K. E. Hillesland, 5 October 1994. These results are tabulated below;

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Table 1. 102-AP Pump Internal Source Term			
Isotope		Worst Case	Average Case
	Ci/cm ³	Ci	Ci
¹⁴ C	5.280e-10	1.93e-04	2.82e-06
⁹⁹ Tc	8.940e-08	3.27e-02	4.77e-04
¹²⁹ I	3.710e-11	1.36e-05	1.98e-07
⁶³ Ni	1.250e-11	4.57e-06	6.68e-08
⁹⁰ Sr	1.470e-06	5.37e-01	7.85e-03
⁹⁰ Y	1.470e-06	5.37e-01	7.85e-03
¹⁰⁶ Ru	2.520e-06	9.21e-01	1.35e-02
¹⁰⁶ Rh	2.520e-06	9.21e-01	1.35e-02
¹²⁵ Sb	7.350e-07	2.69e-01	3.92e-03
^{125m} Te	1.801e-07	6.59e-02	9.60e-04
¹³⁷ Cs	2.310e-04	8.44e+01	1.23e+00
^{137m} Ba	2.188e-04	7.99e+01	1.17e+00
¹⁴⁴ Ce	1.360e-06	4.97e-01	7.26e-03
¹⁴⁴ Pr	1.360e-06	4.97e-01	7.26e-03
²³⁸ Pu	1.630e-10	5.96e+05	8.70e-07
^{239/240} Pu	7.440e-11	2.72e-05	3.97e-07
²⁴¹ Pu	4.200e-09	1.53e-03	2.24e-05
^{241/242} Am	5.270e-10	1.93e-04	2.81e-06
²³⁷ Np	1.000e-09	3.65e-04	5.34e-06
²⁴² Cm	1.540e-08	5.63e-03	8.22e-05
^{243/244} Cm	6.370e-10	2.33e-04	3.40e-06

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Table 2. 102-AP Pump External Source Term		
	Ci/cm ³	Ci
¹⁴ C	5.280e-10	1.11e-05
⁹⁹ Tc	8.940e-08	1.88e-03
¹²⁹ I	3.710e-11	7.79e-07
⁶³ Ni	1.250e-11	2.63e-07
⁹⁰ Sr	1.470e-06	3.09e-02
⁹⁰ Y	1.470e-06	3.09e-02
¹⁰⁶ Ru	2.520e-06	5.29e-02
¹⁰⁶ Rh	2.520e-06	5.29e-02
¹²⁵ Sb	7.350e-07	1.54e-02
^{125m} Te	1.801e-07	3.77e-03
¹³⁷ Cs	2.310e-04	4.85e+00
^{137m} Ba	2.188e-04	4.59e+00
¹⁴⁴ Ce	1.360e-06	2.86e-02
¹⁴⁴ Pr	1.360e-06	2.86e-02
²³⁸ Pu	1.630e-10	3.42e-06
^{239/240} Pu	7.440e-11	1.56e-06
²⁴¹ Pu	4.200e-09	8.82e-05
^{241/242} Am	5.270e-10	1.11e-05
²³⁷ Np	1.000e-09	2.10e-05
²⁴² Cm	1.540e-08	3.23e-04
^{243/244} Cm	6.370e-10	1.34e-05

The source consists of a volume of liquid retained inside the pump volume as well as a thin (1mm) film of liquid on the outer surfaces. The interior of the pump is designed to be self draining so it is unlikely that a considerable volume of liquid will be retained. However, the worst case estimate does postulate such a holdup of liquid. The average case merely postulates a film on the internal surfaces similar to that on the external surfaces.

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Objections may be raised as to the higher activity of the ^{238}Pu as compared to the $^{239/240}\text{Pu}$. The actinides were reported in the first reference quoted above as less than some value, the value changing with each isotope reported. Thus, these upper bounds on each of these elements represent the limitations of the measurement techniques, rather than their abundance in the waste. In fact, they may all be zero. Among these actinides only $^{241/242}\text{Am}$ has a definite value.

The computer code GXQ was used to calculate the Ψ/Q s for the distances and directions for the nearest site boundary. The meteorological data used were the 1983 to 1991 averages for ground (actually 10m) releases in the 200-W area and for each set of directions and their respective distances to the site boundary a value was chosen which was not exceeded more than 0.5% of the time using the NRC methodology. The worst case of these was then chosen for further use in this analysis.

The worst case for the off-site maximally exposed member of the public turned out to be 10,010 meters west of the solid waste burial ground. The Ψ/Q value used was $2.14 \times 10^{-5} \text{ sec/m}^3$. For the onsite worker, the worst case was 100 m to the east with a Ψ/Q value of $3.41 \times 10^{-2} \text{ sec/m}^3$. The point frequency files were nine year averages (1983-1991) for ground releases in the respective release points.

The computer code GENII was then used to calculate the dose to the affected individual. For assessment of the safety class, only the inhalation and direct radiation pathways for the maximally exposed member of the population are considered. The following libraries were accessed;

GENII Default Parameter Values (28-Mar-90 RAP)
Radionuclide Library - Times < 100 years (23-July-93 PDR)
PNL Food Transfer Factor Library (by Z, with Fr&Os 7/19/93 PDR)
Bioaccumulation Factor Library - (30-Aug-88) RAP
External Dose Factors for GENII in person Sv/yr per Bq/n (8-May-90 R)
Worst-Case Solubilities, Yearly Dose Increments (23-Jul-93 PDR)

Jofu Mishima, in his study of release fraction, has a release fraction of 2×10^{-4} for aqueous solutions 70% of which is in the respirable range. This release fraction was applied to the results obtained from GENII which was run for the entire source term. The results are tabulated below. These doses are, of course, fifty year committed doses. The maximally exposed organ is the bone surfaces due to ^{137}Cs .

Table 3. Expected Doses in Sv (rem)		
	Worst Case	Average Case
Offsite Personnel	$3.9 \times 10^{-8} (3.91 \times 10^{-6})$	$3.3 \times 10^{-9} (3.3 \times 10^{-7})$
Onsite Personnel	$6.2 \times 10^{-5} (6.2 \times 10^{-3})$	$4.8 \times 10^{-6} (4.8 \times 10^{-4})$

The offsite CEDE is below 250 mSv (25 rem) and 5 mSv (0.5 rem), and the onsite dose is below the 50 mSv (5 rem) level.

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Sample Input Deck

```
##### Program GENII Input File ##### 8 Jul 88 ###
Title: 102-AP Pump - Worst Case - Safety Class Analysis
      \GENII\102ap-ws.in                      Created on 10-14-1994 at 15:45
OPTIONS===== Default =====
F Near-field scenario?      (Far-field)  NEAR-FIELD: narrowly-focused
F Population dose?          (Individual)  release, single site
T Acute release?            (Chronic)     FAR-FIELD: wide-scale release,
Maximum Individual data set used          multiple sites
Complete
TRANSPORT OPTIONS===== Section EXPOSURE PATHWAY OPTIONS===== Section
T Air Transport              1           F Finite plume, external          5
F Surface Water Transport    2           T Infinite plume, external        5
F Biotic Transport (near-field) 3,4       F Ground, external              5
F Waste Form Degradation (near) 3,4       F Recreation, external         5
Complete                       T Inhalation uptake              5,6
REPORT OPTIONS=====           F Drinking water ingestion        7,8
T Report AEDE only             F Aquatic foods ingestion        7,8
F Report by radionuclide        F Terrestrial foods ingestion    7,9
F Report by exposure pathway    F Animal product ingestion       7,10
F Debug report on screen        F Inadvertent soil ingestion
INVENTORY #####
4 Inventory input activity units: (1-pCi 2-uCi 3-mCi 4-Ci 5-Bq)
0 Surface soil source units (1- m2 2- m3 3- kg)
Equilibrium question goes here
```

Use when	Release Terms-- transport selected			Basic Concentrations-- near-field scenario, optionally				
	Air Radio- nuclide	Surface Water /yr	Buried Waste /m3	Air /m3	Surface Soil /unit	Deep Soil /m3	Ground Water /L	Surface Water /L
C 14		2.0E-04						
NI63		4.8E-06						
SR90		5.7E-01						
Y 90		5.7E-01						
TC99		3.5E-02						
RU106		9.7E-01						
SB125		2.8E-01						
TE125M		2.8E-01						
I 129		1.4E-05						
CS137		8.9E+01						
CE144		5.3E-01						
PR144		5.3E-01						
NP237		3.9E-04						
PU238		6.3E-05						
PU239		2.9E-05						
PU241		1.6E-03						
AM241		2.0E-04						
CM242		6.0E-03						

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CM244 2.5E-04

Use when	-----Derived Concentrations----- measured values are known			
	Release	Terres.	Animal	Drink
Radio-	Plant	Product	Water	Aquatic
nuclide	/kg	/kg	/L	Food
				/kg

TIME #####

1 Intake ends after (yr)
50 Dose calc. ends after (yr)
0 Release ends after (yr)
0 No. of years of air deposition prior to the intake period
0 No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####

0 Definition option: 1-Use population grid in file POP.IN
0 2-Use total entered on this line

NEAR-FIELD SCENARIOS #####

Prior to the beginning of the intake period: (yr)
0 When was the inventory disposed? (Package degradation starts)
0 When was LOIC? (Biotic transport starts)
0 Fraction of roots in upper soil (top 15 cm)
0 Fraction of roots in deep soil
0 Manual redistribution: deep soil/surface soil dilution factor
0 Source area for external dose modification factor (m2)

TRANSPORT #####

-----AIR TRANSPORT-----SECTION 1-----
0-Calculate PM | 0 Release type (0-3)
1 Option: 1-Use chi/Q or PM value | F Stack release (T/F)
2-Select MI dist & dir | 0 Stack height (m)
3-Specify MI dist & dir | 0 Stack flow (m3/sec)
1.00 Chi/Q or PM value | 0 Stack radius (m)
0 MI sector index (1-5) | 0 Effluent temp. (C)
0 MI distance from release point (m) | 0 Building x-section (m2)
F Use jf data, (T/F) else chi/Q grid | 0 Building height (m)

-----SURFACE WATER TRANSPORT-----SECTION 2-----

0 Mixing ratio model: 0-use value, 1-river, 2-lake
0 Mixing ratio, dimensionless
0 Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0 Transit time to irrigation withdrawal location (hr)
If mixing ratio model > 0:
0 Rate of effluent discharge to receiving water body (m3/s)
0 Longshore distance from release point to usage location (m)
0 Offshore distance to the water intake (m)
0 Average water depth in surface water body (m)
0 Average river width (m), MIXFLG=1 only

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0 Depth of effluent discharge point to surface water (m), lake only

====WASTE FORM AVAILABILITY=====SECTION 3=====

0 Waste form/package half life, (yr)

0 Waste thickness, (m)

0 Depth of soil overburden, m

====BIOTIC TRANSPORT OF BURIED SOURCE=====SECTION 4=====

T Consider during inventory decay/buildup period (T/F)?

T Consider during intake period (T/F)?

0 Pre-Intake site condition.....

1-Arid non agricultural

2-Humid non agricultural

3-Agricultural

EXPOSURE #####

====EXTERNAL EXPOSURE=====SECTION 5=====

0 Exposure time: Residential irrigation:

0 Plume (hr) T Consider: (T/F)

0 Soil contamination (hr) 0 Source: 1-ground water

0 Swimming (hr) 0 2-surface water

0 Boating (hr) 0 Application rate (in/yr)

0 Shoreline activities (hr) 0 Duration (mo/yr)

0 Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)

0 Transit time for release to reach aquatic recreation (hr)

1.0 Average fraction of time submersed in acute cloud (hr/person hr)

====INHALATION=====SECTION 6=====

8766.0 Hours of exposure to contamination per year

0 0-No resus- 1-Use Mass Loading 2-Use Anspaugh model

0 pension Mass loading factor (g/m3) Top soil available (cm)

====INGESTION POPULATION=====SECTION 7=====

0 Atmospheric production definition (select option):

0 0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line

1-Use population-weighted chi/Q

2-Use uniform production

0 3-Use chi/Q and production grids (PRODUCTION will be overridden)

0 Population ingesting aquatic foods, 0 defaults to total (person)

0 Population ingesting drinking water, 0 defaults to total (person)

F Consider dose from food exported out of region (default=F)

Note below: S* or Source: 0-none, 1-ground water, 2-surface water

3-Derived concentration entered above

==== AQUATIC FOODS / DRINKING WATER INGESTION=====SECTION 8=====

F Salt water? (default is fresh)

USE ?	FOOD TYPE	TRAN- SIT hr	PROD- UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr	DRINKING WATER
F	FISH	0.00	0.0E+00	0.00	0.0	0 Source (see above)
F	MOLLUS	0.00	0.0E+00	0.00	0.0	T Treatment? T/F
F	CRUSTA	0.00	0.0E+00	0.00	0.0	0 Holdup/transit(da)

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F PLANTS 0.00 0.0E+00 0.00 0.0 | 0 Consumption (L/yr)

-----TERRESTRIAL FOOD INGESTION-----SECTION 9-----

USE ? T/F	FOOD TYPE	GROW TIME da	IRRIGATION-- S RATE • in/yr	TIME mo/yr	YIELD kg/m2	PROD- UCTION kg/yr	CONSUMPTION-- HOLDUP da	RATE kg/yr
F	LEAF V	0.00	0	0.0	0.0	0.0E+00	0.0	0.0
F	ROOT V	0.00	0	0.0	0.0	0.0E+00	0.0	0.0
F	FRUIT	0.00	0	0.0	0.0	0.0E+00	0.0	0.0
F	GRAIN	0.00	0	0.0	0.0	0.0E+00	0.0	0.0

-----ANIMAL PRODUCTION CONSUMPTION-----SECTION 10-----

USE ? T/F	FOOD TYPE	HUMAN-- CONSUMPTION RATE kg/yr	PROD- HOLDUP da	TOTAL PROD- UCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRAC- TION	GROW TIME da	IRRIGATION-- S RATE * in/yr	TIME mo/yr	STOR- YIELD kg/m3	AGE da
F	BEEF	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.0
F	POULTR	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.0
F	MILK	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.0
F	EGG	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.0
	BEEF					0.00	0.0	0.0	0.00	0.00	0.0
	MILK					0.00	0.0	0.0	0.00	0.00	0.0

#####

Harvey Goldberg
Principal Engineer

CONCURRENCE:

J. Greenberg, Manager
Radiation Physics and Shielding

CHECKLIST FOR INDEPENDENT TECHNICAL REVIEW

DOCUMENT REVIEWED

NUMBER: 8D530-HJG-95-002

TITLE: SAFETY CLASS ANALYSIS FOR THE TANK 102-AP PUMP

AUTHOR(s): H. J. Goldberg

I. Method(s) of Review

- (✓) Input data checked for accuracy
- (✓) Independent calculation performed
 - (✓) Hand calculation
 - () Alternate computer code: _____
- () Comparison to experiment or previous results
- () Alternate method (define) _____

II. Checklist (either check or enter NA if not applied)

- (✓) Task completely defined
- (✓) Activity consistent with task specification
- (✓) Necessary assumptions explicitly stated and supported
- (✓) Resources properly identified and referenced
- (✓) Resource documentation appropriate for this application
- (✓) Input data explicitly stated
- (✓) Input data verified to be consistent with original source
- (NA) Geometric model adequate representation of actual geometry
- (NA) Material properties appropriate and reasonable
- (NA) Mathematical derivations checked including dimensional consistency
- (✓) Hand calculations checked for errors
- (✓) Assumptions explicitly stated and justified
- (✓) Computer software appropriate for task and used within range of validity
- (✓) Use of resource outside range of established validity is justified
- (✓) Software runstreams correct and consistent with results
- (✓) Software output consistent with input
- (✓) Results consistent with applicable previous experimental or analytical findings
- (✓) Results and conclusions address all points and are consistent with task requirements and/or established limits or criteria
- (✓) Conclusions consistent with analytical results and established limits
- (na) Uncertainty assesment appropriate and reasonable
- (na) Other (define) _____

III. Comments: _____

IV. REVIEWER: Paul D. Rittmann

DATE: _____

Paul Rittmann

11-7-94

HEDOP REVIEW CHECKLIST
for
Radiological and Nonradiological Release Calculations

Document Reviewed: SAFETY CLASS ANALYSIS FOR THE TANK 102-AP PUMP

Submitted by: H. J. Goldberg

Date Submitted:

Scope of Review: Entire Document

YES NO* N/A

☒	☐	☐	1. A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
☒	☐	☐	2. Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
☒	☐	☐	3. HEDOP-approved code(s) were used.
☒	☐	☐	4. Receptor locations were selected according to HEDOP recommendations.
☒	☐	☐	5. All applicable environmental pathways and code options were included and are appropriate for the calculations.
☒	☐	☐	6. Hanford site data were used.
☒	☐	☐	7. Model adjustments external to the computer program were justified and performed correctly.
☒	☐	☐	8. The analysis is consistent with HEDOP recommendations.
☐	☐	☒	9. Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
☒	☐	☐	10. Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.

* All "NO" responses must be explained and use of nonstandard methods justified.

Reviewer Name: Paul D. Rittmann, B.A., M.S., Ph.D., C.H.P.
(print or type)

Paul Rittmann
HEDOP-Approved Reviewer (Signature)

11-7-94
Date