AUG 01 1997 Sta. 37 (20)

ENGINEERING DATA TRANSMITTAL

1. EDT 607693

2. To: (Receiving Organization) TWRS FSAR DE&S Hanford, Inc.	3. From: (Originating Organization) Fluor Daniel Northwest Safety Analysis & Risk Assessment	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: TWRS FSAR	6. Design Authority/ Design Agent/Cog. Engr.: R. J. Van Vleet	7. Purchase Order No.: N/A

8. Originator Remarks:
Calculation notes are used to document the originator's analysis. They are not to be used as the final or sole document for affecting changes to the authorization basis (authorize activities), to the design basis (justify facility modifications), or to a safety basis.

9. Equip./Component No.: N/A

10. System/Bldg./Facility: 241-SY-101

11. Receiver Remarks: 11A. Design Baseline Document? [] Yes [X] No

12. Major Assm. Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-SD-TWR-CN-001	1-12	0	A Discussion on the Safety Classification of the Tank 241-SY-101 Mixer Pump	N/A	1/2	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority				1	1	Peer Rev. R. M. Marusich	[signature]	7/25/97	A3-34
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1	1	Cog. Mgr. B.E. Hey	[signature]	7/24/97	A3-34						
		QA									
		Safety									
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required)
R. J. Van Vleet [signature] 07/24/97 Signature of EDT Originator / Date	G. W. Ryan [signature] 7/25/97 Authorized Representative for Receiving Organization / Date	B.E. Hey [signature] 7/25/97 Design Authority/ Cognizant Manager / Date	Ctrl. No. N/A [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

BD-7400-172-1 (07/91)

A Discussion on the Safety Classification of the Tank 241-SY-101 Mixer Pump

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U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 607693 UC: 2000
Org Code: 403 Charge Code: N1666/E66124/P3WP00
B&R Code: EW3120071 Total Pages: ~~12~~ 13

Key Words: safety classification, mixer pump, SY-101, 241-SY-101, flammable gases, hydrogen

Abstract: An analysis, consistent with the methodology used in the draft TWRS FSAR (HNF-SD-WM-SAR-067), is presented to show that the classification of the mixer pump in tank 241-SY-101 should be safety significant.

CONTENTS

LIST OF TABLES

ATTACHMENT

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A Discussion on the Safety Classification of the Tank 241-SY-101 Mixer Pump

1.0 PURPOSE

The purpose of this calculation note is to evaluate whether the Tank 241-SY-101 unmitigated deflagration consequences calculated with a tank-specific source term (instead of the DST liquids and DST solids unit liter doses used for the TWRS BIO and TWRS FSAR) would warrant the mixer pump being classified as safety class or safety significant.

2.0 METHODOLOGY

The methodology that will be followed in this calculation note is summarized in the next few sentences. The procedure for determining safety class is WHC-CM-4-46, *Safety Analysis Manual*. The procedure, *Safety Structures, Systems, and Components,* requires that the unmitigated consequences from an accident be compared against criteria to determine the safety classification. If the safety structure, system or component places or maintains an operating process in a safe condition that prevents or mitigates consequences to the public in excess 0.005 Sv (0.5 rem) EDE it is designated safety class (SC). If the safety structure, system or component prevents or mitigates onsite exposure to radiological materials in excess of 0.05 Sv (5 rem) EDE it is designated safety significant (SS). The procedure also allows for the use of the risk guidelines if the frequency is well-known and well-documented.

The risk guidelines for the TWRS BIO and TWRS FSAR were chosen by the U.S. Department of Energy, Headquarters. Table 1 gives the risk guidelines that were used.

Table 1. Risk Guidelines used for the TWRS BIO and TWRS FSAR.

Receptor	Dose limits for each frequency category, Sv (rem)		
	Anticipated	Unlikely	Extremely Unlikely
Onsite	0.005 (0.5)	0.050 (5.0)	0.100 (10.0)
Offsite	0.001 (0.1)	0.005 (0.5)	0.040 (4.0)

The unmitigated frequency for a release and burn of ~50% of the retained gas is anticipated (WHC-SD-WM-TI-753) whereas the frequency of a release and burn of 100% of the retained gas volume is extremely unlikely (WHC-SD-WM-TI-753).

The first step will be to develop a tank-specific unit liter dose for Tank 241-SY-101. This tank-specific unit liter dose will then be used in calculate the onsite receptor at 100 m and the offsite receptor effective dose equivalents for two different size deflagrations. The amount of material released for these burns will be the same as that used for the TWRS FSAR as documented in WHC-SD-WM-TI-753, *Summary of Flammable Gas Hazards and Potential Consequences in Tank Waste Remediation System Facilities at the Hanford Site*. These material inventories will be used to calculate consequences and will be used with the frequencies from WHC-SD-WM-TI-753 to compare against the guidelines for determining the mixer pump safety classification.

3.0 ASSUMPTIONS

The scenario in this assessment assumes that Tank 241-SY-101 releases gas, an ignition source is present, and the gas completely burns yielding the adiabatic isochoric complete combustion pressure. These pressures are assumed to cause structural damage to the tank. The first burn evaluated causes the dome to crack while the second burn evaluated causes complete dome loss as described in WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks.*

4.0 INPUT DATA AND CALCULATION

4.1 TANK SPECIFIC UNIT LITER DOSE

To do this, a unit liter dose is developed for the Tank 241-SY-101 source term. The source term from LA-UR-92-3196, Appendix G, Table G-1 is shown as columns 1 and 2 in the Table 2 below. The Ci/kg numbers were converted into Bq/L using the conversion of 3.7×10^{10} Bq/Ci and a density of 1.65 kg/L from the tank characterization report, WHC-SD-WM-ER-409 (results are in the third column of table). A dose conversion factor for inhalation, Sv/Bq, from EPA-520/1-88-020 (column four of the table) multiplied by the activity, Bq/L (third column), gives a unit liter dose, Sv/L (fifth column), for each isotope.

These individual unit liter doses for each isotope are then summed to give the overall tank-specific unit liter dose. As shown in the Table 2 above, the ULD for Tank 241-SY-101 is 6.135×10^{3} Sv/L.

Table 2. 241-SY-101 Radiological Source Term.

	Activity		DCF	ULD
Isotope	(Ci/kg)	(Bq/L)	(Sv/Bq)	(Sv/L)
^{90}Sr	3.4E-02	2.1E+09	6.47E-08	1.3E+02
^{90}Y	3.4E-02	2.1E+09	2.28E-09	4.7E+00
^{99}Tc	3.0E-04	1.8E+07	2.25E-09	4.1E-02
^{129}I	2.9E-04	1.8E+07	4.69E-08	8.3E-01
^{137}Cs	4.5E-01	2.7E+10	8.63E-09	2.4E+02
^{237}Np	5.1E-04	3.1E+07	1.46E-04	4.5E+03
^{239}Pu	1.6E-05	9.8E+05	1.16E-04	1.1E+02
^{240}Pu	1.0E-09	6.1E+01	1.16E-04	7.1E-03
^{241}Am	1.5E-04	9.2E+06	1.20E-04	1.1E+03
			Total	6135

4.2 DIFFERENCES IN CONSEQUENCE MODELS

LA-UR-92-3196 uses a computer code called AI-RISK to calculate the dose consequences for the deflagration scenarios. This computer code is different than GXQ and GENII, the two codes approved for use by the Hanford Environmental Dose Overview Panel. The use of GENII is mandated for site operations by the U.S. Department of Energy. AI-RISK calculates the atmospheric dispersion coefficient differently than GXQ and GENII. For example, the 100 m atmospheric dispersion coefficient from LA-UR-92-3196 is 1.4 x 10^{-2} m/s^3 whereas from GXQ or GENII it is 3.41 x 10^{-2} m/s^3. In addition, AI-RISK has a plume depletion mechanism that would not be used if the work was done at Hanford. These two items cause the dose at the 100 m receptor to be lower than that calculated here.

4.3 POTENTIAL GAS RELEASE FRACTION FOR AN UNMITIGATED BURN

PNNL-11391 states that the rollover events in Tank 241-SY-101 before the mixer pump was installed released around 50% of the retained gas. The premise is made that since the energy imparted to the waste is the same for a 100-year earthquake as it was for a rollover in Tank 241-SY-101, a 100-year earthquake might cause a rapid release of ~50% of the retained gas in a double-shell tank. It also states that the 1000-year earthquake will cause more than 50% of the retained gas to be released from a double-shell tank. This is why the FSAR analysis looked at a spectrum of accidents for flammable gas tanks. The analysis provided in this letter will look at a 50% release of the retained gases (this is similar to the natural releases prior to pump installation in Tank 241-SY-101) and a 100% release of the retained gas (this is the upper bound and was chosen to represent the 1000-year earthquake). Other factors combine with the release frequency to give an overall frequency for the release and burn of 100% of the volume of retained gas of extremely unlikely (WHC-SD-WM-TI-753).

4.4 CONSEQUENCE CALCULATIONS

The following formula is used to calculate the dose consequences.

$$CEDE = \left(\frac{\chi}{Q}\right)(Q)\,(B_R)\,(ULD)$$

where

CEDE = committed effective dose equivalent (Sv),
χ/Q = atmospheric dispersion coefficient (s/m^3), at a given downwind distance,
Q = amount of material released (L),
B_R = breathing rate (m^3/s), and,
ULD = unit liter dose (Sv/L).

Table 3 provides the calculation of the consequences for a release and burn of ~50% of the retained gas volume and for a release and burn of 100% of the retained gas volume.

Table 3. Dose Consequence Calculations.

Receptor	χ/Q[a] (s/m^3)	Q[b] (L)	B_R[a] (m^3/s)	ULD (Sv/L)	CEDE (Sv)
Release and Burn of ~50% of the Retained Gas Volume					
Onsite	3.41E-02	2.76	3.30E-04	6.135E+03	0.1905
Offsite	2.83E-05	2.76	3.30E-04	6.135E+03	0.000158
Release and Burn of 100% of the Retained Gas Volume[c]					
Onsite	3.41E-02	99.36	3.30E-04	6.135E+03	6.8595
Offsite	2.83E-05	99.36	3.30E-04	6.135E+03	0.005693

[a]WHC-SD-WM-SARR-016.
[b]WHC-SD-WM-TI-753.
[c]The release and burn of 100% of the retained gas volume is modeled as a detonation in WHC-SD-WM-TI-753.

5.0 RESULTS

The consequences reported in LA-UR-92-3196 are presented below in Table 4. The consequences from an unmitigated release and burn of ~50% and 100% of the retained gas volume in Tank 241-SY-101 using the tank specific unit liter dose are also presented.

Table 4. Comparison of Consequences for Different Burns.

Receptor	Consequences (Sv)		
	LANL[a]	**~50%**	**100%**
Onsite	0.1191	0.1905	6.8595
Offsite	0.000052[b]	0.000158	0.005693

[a]LANL uses a different consequence code called AI-RISK. It calculated the atmospheric dispersion coefficient differently than GXQ and GENII. AI-RISK also uses a depletion model.
[b]LANL uses a different offsite receptor located at 13.8 km WNW than the TWRS FSAR where the offsite receptor is 8.76 km N. This causes the offsite dose to be smaller than that calculated in the TWRS FSAR.

6.0 CONCLUSIONS

The *Safety Structures Systems and Components* procedure in WHC-CM-4-46 is used to classify structures, systems, and components. If the frequency of occurrence is well known and documented, the risk guidelines can be used to determine safety classification. That is, a piece of equipment would be considered Safety Class if it prevents or mitigates consequences to the public in excess of 0.001 Sv (0.1 rem) for an anticipated event, 0.005 Sv (0.5 rem)for an unlikely event, or 0.040 Sv (4.0 rem) for an extremely unlikely event. Furthermore, a piece of equipment would be considered Safety Significant if it prevents or mitigates onsite exposure to radiological materials in excess of 0.005 Sv (0.5 rem) for an anticipated, 0.050 Sv (5.0 rem) for an unlikely event, and 0.100 Sv (10.0 rem) for an extremely unlikely event.

Release and Burn of 50% of the Retained Gas Volume. The unmitigated frequency for this burn is anticipated per WHC-SD-WM-TI-753. It is reasonable to assume that this frequency designation fits the definition of being well known and documented. Thus, the anticipated event guidelines will be used for determining the safety classification of the mixer pump. The offsite consequence for this event is 0.000158 Sv (0.0158 rem) which is well below 0.001 Sv (0.1 rem), the offsite guideline for anticipated events. The onsite consequence for this event is 0.1905 Sv (19.05 rem) which exceeds 0.005 Sv (0.5 rem), the onsite guideline for anticipated events. Therefore, based on this comparison, the release and burn of 50% of the retained gas volume would cause the mixer pump to be classified as Safety Significant.

Release and Burn of 100% of the Retained Gas Volume. The unmitigated frequency for this burn is extremely unlikely per WHC-SD-WM-TI-753. However, this frequency designation does not fit the definition of being well known and documented. Thus, the both the extremely unlikely and unlikely guidelines will be used for comparison in the paragraphs below.

The offsite dose consequences for the unmitigated release and burn of 100% of the retained gas volume is 0.005693 Sv (0.5693 rem) which is less than 0.040 Sv (4.0 rem), the offsite guideline for extremely unlikely events. The onsite consequence is 6.8595 Sv (685.95 rem) which exceeds 0.100 Sv (10 rem), the onsite guideline. Therefore, based upon this comparison, the release and burn of 100% of the retained gas volume would cause the mixer pump to be classified as Safety Significant.

If the frequency of the unmitigated release and burn of 100% of the retained gas volume was an unlikely event, instead of extremely unlikely, a similar comparison can be made. As stated above, the calculated offsite dose consequence is 0.005693 Sv (0.5693 rem). Because of the many conservatisms in the analysis, it is judged that this is essentially the same as the 0.005 Sv (0.5 rem), the offsite guideline for unlikely events. The onsite consequence, as stated above, is 6.8595 Sv (685.95 rem) which exceeds 0.050 Sv (5 rem), the onsite guideline for unlikely events. In light of this discussion, it can be argued that the mixer pump safety classification is also Safety Significant.

In conclusion, an analysis and comparison of unmitigated consequences has been done, and based on this analysis, it can be argued that the mixer pump in Tank 241-SY-101 should have a safety classification of Safety Significant.

7.0 REFERENCES

EPA-520/1-88-020, 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, U.S. Environmental Protection Agency, Washington, D.C.

LA-UR-92-3196, 1995, *A Safety Assessment for Proposed Mixing Pump Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101: Hanford Site, Richland, Washington*, Rev. 14, Los Alamos National Laboratory, Los Alamos, New Mexico.

PNNL-11391, 1996, *Gas Retention and Release Behavior in Hanford Single-Shell Waste Tanks*, Pacific Northwest National Laboratory, Richland, Washington.

WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-409, 1995, *Tank Characterization Report for Double-Shell Tank 241-SY-101*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-SARR-016, 1996, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for Use in Safety Analysis Consequence Assessments*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-753, *Summary of Flammable Gas Hazards and Potential Consequences in Tank Waste Remediation System Facilities at the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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ATTACHMENT 1: PEER REVIEW CHECKLIST

CHECKLIST FOR PEER REVIEW

Document Reviewed: HNF-SD-TWR-CN-001, Rev. 0, *A Discussion on the Safety Classification of the Tank 241-SY-101 Mixer Pump*

Scope of Review: Entire document.

Yes	No	NA	
[ ]	[ ]	[X]*	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[ ]	[ ]	[X]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity or use outside range of established validity justified.
[ ]	[ ]	[X]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[ ]	[ ]	[X]	Software input correct and consistent with document reviewed.
[ ]	[ ]	[X]	Software output consistent with input and with results reported in document reviewed.
[X]	[ ]	[ ]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[ ]	[ ]	[X]	Format consistent with appropriate NRC Regulatory Guide or other standards
[ ]		[X]*	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	**Document approved.**

R. M. Marusich [signature] 07/18/97

Reviewer (Printed Name and Signature) Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

DISTRIBUTION SHEET

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TWRS FSAR DE&S Hanford, Inc.	Fluor Daniel Northwest Safety Analysis & Risk Assessment	Date 07/24/97
Project Title/Work Order		EDT No. 607693
A Discussion on the Safety Classification of the Tank 241-SY-101 Mixer Pump		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
B.E. Hey	A3-34	X			
D.F. Hicks	A3-34	X			
R.M. Marusich	A3-34	X			
G.W. Ryan	A3-34	X (2)			
R.J. Van Vleet	A3-34	X			
Central Files	A3-88	X (Original + 1)			
Docket Files	B1-17	X (2)			
TWRS S&L Files	A2-26	X (2)			