HNF-36218
Revision 1

Potential for Hydrogen Buildup in Hanford Sealed Air Filled Nuclear Storage Vessels

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

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Revision 1
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RECORD OF REVISION	(1) Document Number HNF-36218	Page 1 of 1

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Potential for Hydrogen Buildup in Hanford Sealed Air Filled Nuclear Storage Vessels

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Calculation Cover Sheet and Revision Summary

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1. Project Identifier PFP	2. Modification Description Title/Subject **Potential for Hydrogen Buildup in Hanford Sealed Air Filled Nuclear Storage Vessels**	3. Page 1 of 10

4. Use of Form

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0	Print Name	Brit E. Hey	Keith A. Larkin	Brenda D. Pritchett	NA	☐ Yes ☑ No
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	Date	3/10/08	3/10/08	3/10/08		
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A-6003-083 (REV 1)

Potential for Hydrogen Buildup in Hanford Sealed Air Filled Nuclear Storage Vessels

1.0 Purpose

This calculation is performed in accordance with HNF-PRO-8259, *PHMC Calculation Preparation and Issue* and addresses the question as to whether a flammable mixture of hydrogen gas can accumulate in a Hanford sealed nuclear storage vessel where the only source of hydrogen is the moisture in the air that initially filled the vessel. Of specific concern is nuclear fuel inside IDENT 69-Gs, placed in Core Component Containers (CCCs) located inside Interim Storage Vaults (ISVs) at the Plutonium Finishing Plant (PFP). The CCCs are to be removed from the ISVs and placed inside a Hanford Unirradiated Fuel Package (HUFP) for transport and interim storage. The repackaging procedures mandated that no plastics were permitted, all labels and tape were to be removed and the pins to be clean and inspected. Loading of the fuel into the CCC/ISV package was permitted only if it was not raining or snowing. This was to preclude the introduction of any water. The purpose was to minimize the presence of any hydrogenous material inside the storage vessels. The scope of NFPA 69, *Standard on Explosion Prevention Systems*, precludes its applicability for this case.

The reactor fuel pins are helium bonded. The non-fuel pins, such as the pellet stacks, are also helium bonded. The fuel pellets were sintered at temperatures that preclude any residual hydrogenous material.

Hydrogen gas can be formed from neutron and gamma radiolysis of water vapor. The radiolysis reaction is quite complex involving several intermediate radicals, and competing recombination reactions. Hydrogen gas can also be formed through corrosion. This analysis takes a simplistic approach and assumes that all water vapor present in the storage vessel is decomposed into hydrogen gas. Although the analysis is needed to specifically address HUFP storage of nuclear fuel, it is equally applicable to any sealed fuel storage vessel under the assumptions listed below.

2.0 Assumptions

The following list of assumptions are used in this analysis:

- There are no hydrocarbons or other sources of hydrogen in the vessel other than the moisture in the air at initial storage.
- The storage vessel is sealed and not interconnected to any other vessel or line.
- The storage vessel was sealed at Hanford at atmospheric pressure (760 torr) under conditions of zero precipitation.
- All water vapor within the vessel is decomposed into hydrogen gas.
- No hydrogen escapes the vessel.

- At atmospheric pressure the flammable range is approximately 4 percent to 75 percent by volume of hydrogen in air [NFPA 55 2005 Edition].

3.0 Calculation

3.1 Methodology

Tables 1 through 5 present temperature and humidity data from Hanford climatological records as well as calculated moisture content. The following description is typical of all four tables. Columns 2 and 6 contain temperature and relative humidity from climatological records. Column 5 contains saturated water vapors calculated from two arbitrary points (15 C, 12.788 torr) and (24 C, 22.377 torr) taken from the CRC Handbook of Chemistry and Physics and the equation $\ln(P_3/P_1) = [T_2(T_3-T_1)/(T_3(T_2-T_1)] \ln(P_2/P_1)$ taken from Marks' Standard Handbook for Mechanical Engineers. Column 7 is the actual vapor pressure which is the product of saturated vapor pressure and average relative humidity. Column 8 is water concentration which is actual vapor pressure divided by total atmospheric pressure (assumed to be 760 torr). Both average (best estimate) and bounding (conservative) conditions are evaluated.

3.2 Average Conditions

The air at Hanford has a low relative humidity. Relative humidity is the ratio of the actual water-vapor content of the air to the saturated condition at the given pressure and temperature. According to Poston 2007, *Hanford Site Environmental Report for Calendar Year 2006 (including Some Early 2007 Information)*, the annual average relative humidity at the Hanford Meteorology station is 54.6%. Humidity is highest during winter, averaging approximately 76% and lowest during summer, averaging approximately 36%. Normal monthly average temperature at the Hanford Meteorology Station ranges from a low of -0.2^{0}C (31.7^{0}F) in December to a high of 24.6^{0}C (76.2^{0}F) in July. During the summer, the record maximum monthly average temperature was 27.9^{0}C (82.2^0 F) in July 1985.

As shown in Table 1 the relative humidity is highest in the winter when the temperature and correspondingly the vapor pressure of water are the lowest, and the humidity is lowest in the summer when the temperature and the vapor pressure of water are the highest. The table lists the average monthly temperature and humidity at Hanford over the period 1950-2004 (PNNL-15160). With the nominal inverse relationship of humidity and temperature the average yearly vapor pressure of water is 5.8 torr, ranging from a low of 3.5 torr in January to a high of 8.2 torr in August. The average water vapor concentration in the Hanford air is 0.8%, reaching a high of 1.1% in the summer months and a low of 0.5% in the winter months.

Table 1. Atmospheric Water Concentration Based on Hanford Meteorological Data (1950-2004)

Month	Average Monthly Temp (F)*	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)*	Actual Vapor Pressure (torr)	Water Concentration (%)
Jan	31.4	-0.3	272.8	4.5	77.6	3.5	0.5
Feb	37.6	3.1	276.3	5.8	70.7	4.1	0.5
Mar	45.3	7.4	280.5	7.7	56.6	4.4	0.6
Apr	53.3	11.8	285.0	10.4	47.5	4.9	0.7
May	62.1	16.7	289.9	14.3	43	6.1	0.8
Jun	69.9	21.1	294.2	18.7	39.6	7.4	1.0
Jul	77.4	25.2	298.4	24.1	33.3	8.0	1.1
Aug	75.8	24.3	297.5	22.8	35.7	8.2	1.1
Sep	66.5	19.2	292.3	16.6	42.1	7.0	0.9
Oct	53.1	11.7	284.9	10.3	56.1	5.8	0.8
Nov	40.1	4.5	277.7	6.4	73.6	4.7	0.6
Dec	32.7	0.4	273.5	4.8	80.4	3.8	0.5
Avg.	53.8	12.1	285.3	10.6	54.6	5.8	0.8

* Measured Data

3.3 Bounding Conditions

The IDENT 69-Gs were loaded into CCCs at PFP during the September to October 2005 time frame. Climatological data taken from the Hanford Meteorology Station (HMS) during the months of September and October 2005 are provided in Tables 2 and 3 along with the calculated water concentration. The HMS is located approximately 25 miles northwest of Richland, Washington and about 1.5 miles from PFP.

Table 2. Atmospheric Water Concentration Based on Hanford Meteorological Data (September 2005)

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
1	72	22.2	295.4	20.1	33	6.6	0.9
2	75	23.9	297.0	22.2	35	7.8	1.0**
3	70	21.1	294.3	18.8	36	6.8	0.9
4	66	18.9	292.0	16.4	41	6.7	0.9
5	64	17.8	290.9	15.3	39	5.9	0.8
6	68	20.0	293.2	17.5	32	5.6	0.7
7	70	21.1	294.3	18.8	28	5.3	0.7
8	73	22.8	295.9	20.8	30	6.2	0.8
9	64	17.8	290.9	15.3	38	5.8	0.8
10	59	15.0	288.2	12.8	58	7.4	1.0*
11	60	15.6	288.7	13.3	53	7.0	0.9
12	66	18.9	292.0	16.4	43	7.0	0.9
13	66	18.9	292.0	16.4	44	7.2	0.9

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
14	67	19.4	292.6	16.9	38	6.4	0.8
15	68	20.0	293.2	17.5	38	6.7	0.9
16	61	16.1	289.3	13.7	49	6.7	0.9
17	64	17.8	290.9	15.3	43	6.6	0.9
18	61	16.1	289.3	13.7	45	6.2	0.8
19	66	18.9	292.0	16.4	40	6.5	0.9
20	66	18.9	292.0	16.4	37	6.1	0.8
21	62	16.7	289.8	14.2	31	4.4	0.6
22	59	15.0	288.2	12.8	29	3.7	0.5
23	63	17.2	290.4	14.7	26	3.8	0.5
24	62	16.7	289.8	14.2	30	4.3	0.6
25	60	15.6	288.7	13.3	35	4.6	0.6
26	62	16.7	289.8	14.2	36	5.1	0.7
27	66	18.9	292.0	16.4	36	5.9	0.8
28	62	16.7	289.8	14.2	37	5.3	0.7
29	66	18.9	292.0	16.4	43	7.0	0.9
30	64	17.8	290.9	15.3	75	11.4	1.5*
Avg.	65.2	18.4	291.6	15.9	39.4	6.3	0.8

* Measurable Precipitation

** Trace Precipitation

Table 3. Atmospheric Water Concentration Based on Hanford Meteorological Data (October 2005)

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
1	52	11.1	284.3	9.9	70	7.0	0.9**
2	49	9.4	282.6	8.9	68	6.0	0.8**
3	52	11.1	284.3	9.9	77	7.6	1.0*
4	51	10.6	283.7	9.6	75	7.2	0.9
5	54	12.2	285.4	10.7	67	7.2	0.9
6	60	15.6	288.7	13.3	62	8.2	1.1*
7	56	13.3	286.5	11.5	63	7.2	1.0
8	52	11.1	284.3	9.9	64	6.4	0.8
9	54	12.2	285.4	10.7	66	7.1	0.9
10	54	12.2	285.4	10.7	67	7.2	0.9
11	58	14.4	287.6	12.3	52	6.4	0.8
12	56	13.3	286.5	11.5	69	7.9	1.0**
13	61	16.1	289.3	13.7	50	6.9	0.9**
14	58	14.4	287.6	12.3	57	7.0	0.9
15	62	16.7	289.8	14.2	46	6.5	0.9
16	55	12.8	285.9	11.1	58	6.4	0.8
17	59	15.0	288.2	12.8	60	7.7	1.0
18	62	16.7	289.8	14.2	49	7.0	0.9
19	62	16.7	289.8	14.2	57	8.1	1.1*
20	58	14.4	287.6	12.3	60	7.4	1.0

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
21	56	13.3	286.5	11.5	68	7.8	1.0
22	56	13.3	286.5	11.5	66	7.6	1.0
23	51	10.6	283.7	9.6	76	7.3	1.0
24	52	11.1	284.3	9.9	77	7.6	1.0
25	54	12.2	285.4	10.7	72	7.7	1.0**
26	48	8.9	282.0	8.6	60	5.1	0.7**
27	44	6.7	279.8	7.4	75	5.5	0.7
28	50	10.0	283.2	9.2	75	6.9	0.9*
29	47	8.3	281.5	8.3	67	5.5	0.7
30	45	7.2	280.4	7.7	64	4.9	0.6
31	54	12.2	285.4	10.7	75	8.0	1.1*
Avg.	54.5	12.5	285.7	10.9	64.9	7.1	0.9

* Measurable Precipitation
** Trace Precipitation

On no day did the calculated water concentration exceed 1% without there being measurable precipitation recorded. The work packages used to load CCCs into the ISVs (2Z-05-0857) and ID-69s into the CCCs (2Z-05-00760) precluded work during unfavorable weather conditions (e.g., high wind, rain, snow, blowing dust), and required that CCCs be unloaded and dried if there were the possibility of water intrusion.

Based on Table 1 the highest water concentration in Hanford air occurs during the summer months. Table 4 and 5 provide the climatological data and calculated water concentration for July and August 2005. Understandably the highest air moisture concentrations occurred during days of precipitation. On days of zero precipitation the highest air moisture concentration was 1.3%.

Table 4. Atmospheric Water Concentration Based on Hanford Meteorological Data (July 2005)

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
1	74	23.3	296.5	21.5	30	6.4	0.8
2	72	22.2	295.4	20.1	35	7.0	0.9
3	70	21.1	294.3	18.8	32	6.0	0.8
4	76	24.4	297.6	23.0	27	6.2	0.8
5	80	26.7	299.8	26.2	29	7.6	1.0
6	76	24.4	297.6	23.0	38	8.7	1.1
7	72	22.2	295.4	20.1	34	6.8	0.9
8	73	22.8	295.9	20.8	50	10.4	1.4*
9	69	20.6	293.7	18.1	54	9.8	1.3
10	71	21.7	294.8	19.4	40	7.8	1.0
11	76	24.4	297.6	23.0	35	8.0	1.1
12	75	23.9	297.0	22.2	35	7.8	1.0
13	74	23.3	296.5	21.5	32	6.9	0.9

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
14	77	25.0	298.2	23.8	30	7.1	0.9
15	80	26.7	299.8	26.2	30	7.9	1.0
16	76	24.4	297.6	23.0	37	8.5	1.1
17	78	25.6	298.7	24.6	31	7.6	1.0
18	80	26.7	299.8	26.2	28	7.3	1.0
19	84	28.9	302.0	29.9	20	6.0	0.8
20	78	25.6	298.7	24.6	23	5.6	0.7
21	82	27.8	300.9	28.0	22	6.2	0.8
22	78	25.6	298.7	24.6	39	9.6	1.3**
23	74	23.3	296.5	21.5	35	7.5	1.0
24	76	24.4	297.6	23.0	26	6.0	0.8
25	78	25.6	298.7	24.6	25	6.1	0.8
26	80	26.7	299.8	26.2	24	6.3	0.8
27	82	27.8	300.9	28.0	20	5.6	0.7
28	86	30.0	303.2	31.9	22	7.0	0.9
29	85	29.4	302.6	30.9	24	7.4	1.0
30	86	30.0	303.2	31.9	25	8.0	1.0
31	84	28.9	302.0	29.9	25	7.5	1.0
Avg.	77.5	25.3	298.4	24.2	30.8	7.4	1.0

* Measurable Precipitation

** Trace Precipitation

Table 5. Atmospheric Water Concentration Based on Hanford Meteorological Data (August 2005)

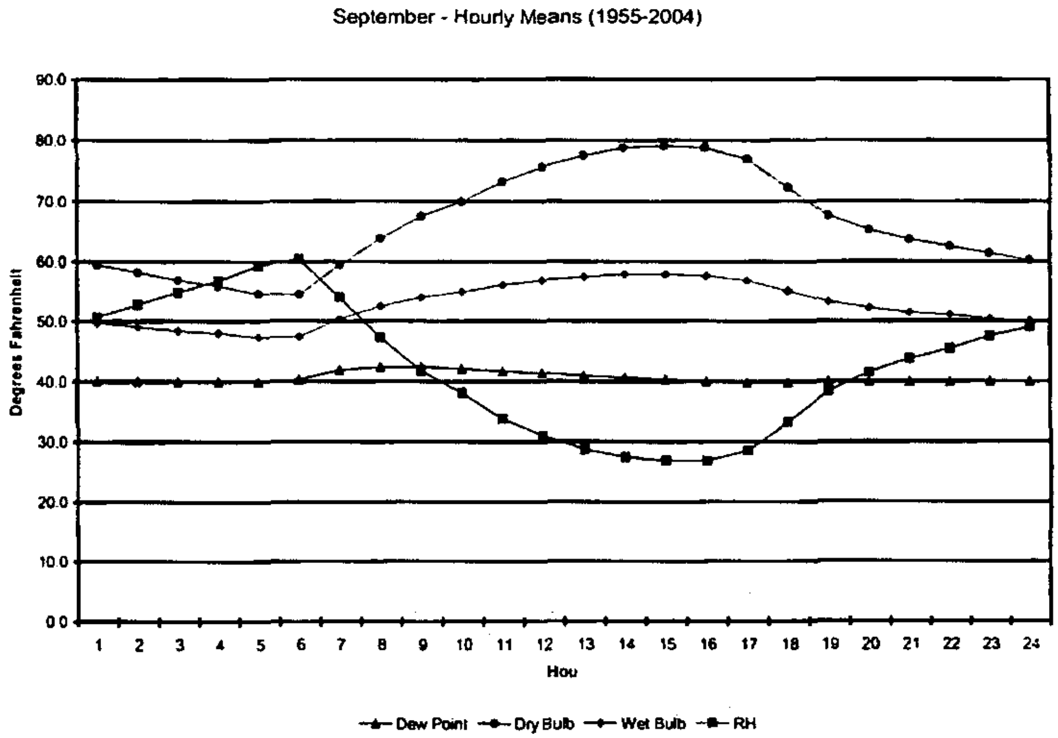
Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
1	79	26.1	299.3	25.4	36	9.1	1.2
2	74	23.3	296.5	21.5	25	5.4	0.7
3	78	25.6	298.7	24.6	21	5.2	0.7
4	80	26.7	299.8	26.2	18	4.7	0.6
5	85	29.4	302.6	30.9	20	6.2	0.8
6	85	29.4	302.6	30.9	22	6.8	0.9
7	84	28.9	302.0	29.9	22	6.6	0.9
8	82	27.8	300.9	28.0	24	6.7	0.9
9	84	28.9	302.0	29.9	26	7.8	1.0
10	80	26.7	299.8	26.2	27	7.1	0.9
11	76	24.4	297.6	23.0	28	6.4	0.8
12	74	23.3	296.5	21.5	39	8.4	1.1
13	74	23.3	296.5	21.5	28	6.0	0.8
14	72	22.2	295.4	20.1	23	4.6	0.6
15	74	23.3	296.5	21.5	25	5.4	0.7
16	81	27.2	300.4	27.1	28	7.6	1.0
17	72	22.2	295.4	20.1	50	10.0	1.3*
18	73	22.8	295.9	20.8	38	7.9	1.0

Day	Average Daily Temp (F)	Temp (C)	Temp (K)	Saturated Vapor Pressure (torr)	Average Relative Humidity (%)	Actual Vapor Pressure (torr)	Water Concentration (%)
19	72	22.2	295.4	20.1	28	5.6	0.7
20	76	24.4	297.6	23.0	27	6.2	0.8
21	86	30.0	303.2	31.9	27	8.6	1.1
22	81	27.2	300.4	27.1	28	7.6	1.0
23	72	22.2	295.4	20.1	34	6.8	0.9
24	70	21.1	294.3	18.8	29	5.4	0.7
25	71	21.7	294.8	19.4	26	5.0	0.7
26	75	23.9	297.0	22.2	26	5.8	0.8
27	78	25.6	298.7	24.6	27	6.6	0.9
28	77	25.0	298.2	23.8	32	7.6	1.0
29	70	21.1	294.3	18.8	39	7.3	1.0**
30	69	20.6	293.7	18.1	38	6.9	0.9
31	68	20.0	293.2	17.5	41	7.2	0.9
Avg.	76.6	24.8	297.9	23.4	29.1	6.8	0.9

* Measurable Precipitation
** Trace Precipitation

Although daily temperature and relative humidity can have a large variation, the moisture content in the air remains essentially constant. This is because as temperature rises so does the saturated water vapor pressure. Hence the relative humidity decreases. Figure 1 is a typical diagram showing the variation in Hanford hourly mean dry bulb temperature and relative humidity for the month of September from 1955 to 2004 (Figure 6.1, PNNL-15160). Note that the highest humidity occurs at the lowest dry bulb temperature (about 6:00 AM) and the lowest humidity occurs at the highest dry bulb temperature (about 3:00 PM). The water vapor pressure at these two extremes is 4.7 to 4.9 torr, a variation of only 5%. The same variation would then be expected for the water concentration.

Figure 1. Hanford September Hourly Means of Dew Point, Dry Bulb, Wet Bulb and RH (1955-2004)



4.0 Summary of Results

Based on the analyses provided above, it is not possible to obtain a flammable concentration of hydrogen in a nuclear storage vessel given the stated assumptions. Hence there should be no concern with respect to hydrogen deflagration. A value of 1.4% (1.3% times 1.05 to account for hourly fluctuations) is a reasonable estimate for a maximum hydrogen concentration given the stated assumptions. Actual hydrogen concentration will be lower due to seasonal variations, incomplete decomposition of water, and diffusion/leakage of gaseous hydrogen through the vessel seals/wall. The attachment contains the Hanford Fire Marshal's Office Interpretation of NFPA 69 applicability.

5.0 References

Climatological Data Hanford Meteorology Station Month Data, http://hms.pnl.gov/

CRC Handbook of Chemistry and Physics, 63rd ed., CRC Press, Inc., Boca Raton, Florida.

HNF-28554, *Hanford Unirradiated Fuel Package (HUFP) Safety Analysis Report (SAR)*, Revision B March 2006, Fluor Hanford, Richland, Washington.

HNF-PRO-8259, *PHMC Calculation Preparation and Issue*, Revision 3, Fluor Hanford, Richland, Washington.

Marks' Standard Handbook for Mechanical Engineers, 9th ed., McGraw-Hill Book Company, New York, New York.

NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, 2005 Edition, NFPA, Quincy, MA.

NFPA 69, *Standard on Explosion Prevention Systems*, 2008 Edition, 2008 Edition, NFPA, Quincy, MA.

PNNL-15160, *Hanford site Climatological Summary 2004 with Historical Data,* May 2005, Pacific Northwest National Laboratories, Richland, Washington.

Poston 2007, TM Poston, RW Hanf, JP Duncan, RL Dirkes, *Hanford Site Environmental Report for Calendar Year 2006 (including Some Early 2007 Information).*

ATTACHMENT

Hanford Fire Marshal's Office Interpretation of NFPA 69

HANFORD FIRE MARSHAL'S OFFICE (HFM) INTERPRETATION/CLARIFICATION REQUEST (ICR)

PART A – REQUEST	
ICR No. (Assigned by Fire Marshal): **CY 2008-02**	
Requestor: C. T. Sadanaga	**Requestor Phone Number:** 372-1378
Request Date: 2-6-2008	**Contractor:** FHI
Response Requested By (date): 2-15-2008	**Project No.** (if applicable): N/A
Project Title (if applicable): PFPCP	**System** (if applicable): N/A
Facility/Area: PFP/200W	**Reference Documents:** N/A
Work Package No. (if applicable): N/A	

Inquiry: This inquiry seeks interpretation of whether NFPA 69, *Standard on Explosion Prevention Systems*, 2008, is applicable to the package described below.

NFPA 69, 1.2 Purpose, states, "This standard shall cover the minimum requirements for installing systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures."

Nuclear fuel placed in a container will be sealed inside a vessel for transport and interim storage. The concern is the formation of hydrogen gas from neutron and gamma radiolysis of water vapor within the vessel.

Calculation results documented in HNF-36218, *Potential for Hydrogen Buildup in Hanford Sealed Air Filled Nuclear Storage Vessels*, indicate that the highest concentration of hydrogen that could be formed from decomposition of water in the air within the vessel is not expected to exceed 1.4%. This value assumes:

1. No hydrocarbons or other sources of hydrogen are in the vessel other than the moisture in the air at initial storage. The repackaging procedures mandated that no plastics were permitted, all labels and tape were removed, and the fuel pins to be clean and inspected. Compliance of this requirement was verified at initial loading and will be reveriifed if reloading is required.
2. The vessel is sealed at atmospheric pressure (760 torr) under conditions of zero precipitation. The work packages used to initially load the fuel, i.e., fuel assemblies into core component containers and core component containers (CCC) into interim storage vessels, precluded work during unfavorable weather conditions and required that CCCs be unloaded and dried if there were the possibility of water intrusion. The same control will be maintained for future loading evolutions.
3. Bounding conditions for water concentration within the vessel are based on Hanford Meteorological data. Water concentrations were evaluated over several years in HNF-36218 to evaluate peak values. These values were used as the basis for the assumption.
4. All water vapor within the vessel is decomposed into hydrogen gas.
5. No hydrogen escapes the vessel.

At atmospheric pressure the lower flammable limit (LFL) for hydrogen is approximately 4 percent by volume in air.

Requestor Interpretation/Clarification Proposed Resolution:
The requestor's position is that because the maximum attainable concentration of hydrogen in the vessel (1.4%) is less than the LFL for hydrogen (4%), i.e., it is not possible to obtain a flammable concentration, NFPA 69 does not apply.

Potential Impacts to Personnel/Project/Facility/Operation (Explain if needed):	**Priority**
___ **Potential personnel safety issue** ___ **Potential property damage issue** ___ **Potential Design Deficiency** ___ **Field Installation Conflict** X___ **Cost Avoidance/Cost Impact/Schedule Impact** ___ **Other** (Question/General knowledge, etc.)(Explain) Avoidance of potential cost to perform further analyses.	___ **High** X___ **Medium** ___ **Low**

PART B – RESPONSE	
Request Received By: D. W. Mertz	**Date:** 02-06-2008
Disposition Assignee: (if other than received by);	**Date:**
Confirm Potential Impacts/Priority X___ **Agree with Requestor** ___ **Impact and/or Priority changed** (Explain):	
Disposition: X___ **Proposed resolution or interpretation is accepted.** (See below) ___ **Proposed resolution or interpretation is incomplete/incorrect.** (Provide resolution/interpretation as required.) Based on the purpose of NFPA 69 as stated above, the mitigation techniques described in NFPA 69 do not apply if the concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures cannot reach flammable levels. Verification of assumptions 1. and 2. listed above during operational activities will ensure that flammable levels cannot be reached..	

Disposition Review and Concurrence By:

Print Name: D. W. Mertz **Date:** 02-07-2008

Signature: [signature]

APPROVAL: [signature] **Date:** 2/13/08
R. J. Kobelski