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Evaluation of the Potential For Tank 241-C-106 to Achieve a Flammable Atmosphere

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Abstract: It is planned to have the remaining waste in 241-C-106 removed from the tank so that it can be closed. Since the tank is nearly empty, it has little potential to generate or store flammable gas. This document evaluates the potential to achieve a flammable atmosphere in the tank. Neither steady state nor gas release event conditions can render the tank C-106 headspace flammable.

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EVALUATION OF THE POTENTIAL FOR TANK 241-C-106 TO ACHIEVE A FLAMMABLE ATMOSPHERE

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LIST OF TERMS

BBI	Best-Basis Inventory
ft^3	cubic feet
gal	gallons
GRE	gas release event
LFL	lower flammability limit

1.0 PURPOSE

Tank 241-C-106 (C-106) is currently nearly empty. It is planned to have the remaining waste removed from the tank so that it can be closed as soon as possible. One of the complicating factors in designing and operating equipment in a tank environment is that everything must meet restrictive codes for flammable environments. Since the tank is nearly empty, it has little potential to generate or store flammable gas. The purpose of this document is to evaluate the potential to achieve a flammable atmosphere in the tank. The document is expected to be used to support a change to the Safety Basis that will reclassify this tank as a non-flammable gas tank and ease the design and operating requirements.

2.0 CURRENT TANK CONDITIONS AND INPUT DATA

Tank C-106 is a 75-foot diameter underground storage tank with a design storage capacity of 530,000 gallons. The sludge waste, which was stored in it, was mostly sluiced to tank 241-AY-102 in a series of transfers that ended in 1999. Currently, the ENRAF[1] level gauge contacts solids piled in the tank and cannot give an accurate liquid level. The contents were estimated in the Best-Basis Inventory (BBI) on January 1, 2001 to be 30,000 gallons of liquid waste and 6,000 gallons of solids (TWINS 2002). Since the last BBI update, the tank contents have been more accurately estimated based on a review of a video inspection of the tank contents on August 1, 2002. Evaporation has reduced the liquid content and the lower liquid content allowed a more accurate estimation of the solids. The current contents are estimated to be 18,500 gallons of liquid waste and 9,000 gallons of solids (Riess 2002).

The video inspection showed the solids to be mounded in piles against the tank wall mostly near the pump suction and sluice nozzle location from Project W-320. The solids appear to be mainly chunks similar in nature to a pile of gravel with comparatively little fine solids or mud. The solids composition is assumed to be unchanged from the previous BBI but the mass is adjusted to account for the increased volume.

The video inspection also better reflected the reduced liquid volume. The liquid volume has been reduced by evaporation since the last BBI update, and the video provided a better estimate of the solids. Since evaporation effectively only removes water, all other chemical constituent masses in the liquid phase are assumed to be constant, and the concentrations adjusted to the smaller volume. A comparison of the BBI and current estimated volumes is given in the table below.

Volume	BBI (1/1/01)	Current Estimate RPP-12547 (8/1/02)
Volume Liquid (gal)	30,000	18,500
Volume Solids (gal)	6,000	9,000
Total (gal)	36,000	27,500

[1] ENRAF is a trademark of the ENRAF Corporation, Houston, Texas.

The total tank volume including headspace is 114,000 ft^3 (850,000 gallons).

3.0 EVALUATION METHOD

Flammable gas evaluations consider two tank conditions, steady state and gas release events. The steady state case considers the balance between the flammable gas generation/continuous release rate and the ventilation or breathing rate of the tank. The gas release event considers either the spontaneous or induced rapid release of stored gas inventory from the waste. So long as neither condition can result in a flammable atmosphere in the tank headspace, the tank does not pose a flammable gas hazard. These two conditions will be considered separately in the following sections.

4.0 STEADY STATE GAS RELEASE

Measurements conducted at the end of the previous sluicing campaign estimate a flammable gas generation rate of 96 liters per day (Cuta et al. 2000). This compares with a calculated gas generation rate of 33 liters per day (Hu 2002a). Given the current condition of the tank, Hu (2002b) evaluated the measured generation rate reported in (Cuta et al. 2000) and concluded that it would not exceed 11.7 percent of the lower flammability limit (LFL). He further determined that it would take a hydrogen generation rate of 214 liters per day to cause the tank atmosphere to reach 25 percent of the LFL under barometric breathing conditions. Therefore, under steady state gas release conditions, tank C-106 cannot reach a flammable condition.

5.0 POTENTIAL FOR FLAMMABLE GAS RELEASE EVENT

There is no evidence that flammable gas is retained in the solids that remain in tank C-106. Experience generally associates flammable gas retention with fine solids having limited shear strength. It is unlikely that a "gravel pile" which has been washed of fines such as was done in sluicing tank C-106 would be capable of retaining a significant quantity of flammable gas.

Even if the solids were capable of retaining gas, there is insufficient volume of waste in tank C-106 to render the tank dome space flammable under even the most conservative assumptions for a gas release event. For example, if we assume:

1. The volume of gas stored is equal to the volume of waste, i.e., 27,500 gallons. (Generally, gas volumes are a fraction of the solids volume. Therefore, a more realistic volume estimate would be less than the solids volume of 9000 gallons.)

2. The gas composition is 100 percent hydrogen. (Retained gas sampler data varied between 20 and 80 percent hydrogen with the balance being nonflammable gases. The distribution of

gas composition is bi-modal around ~30 percent and ~60 percent hydrogen. The lower concentration is usually associated with tanks which a have organics associated with the waste such as C-106.)

3. All of the stored gas is released to the dome space at once. (The vast majority of the gas release events (GREs) are less than 5 percent of the stored gas. Even in the case of buoyant displacement GREs, the release did not exceed 50 percent of the stored gas. Release of all of the gas at once exceeds the worst-case globally waste disturbing (induced) gas release event.)

Then we can calculate a bounding case:

Volume of flammable gas = Volume of waste = 27,500 gallons * 0.13368 ft^3/gal = 3676.2 ft^3

Volume of tank headspace = Volume of tank – Volume of waste
= 114,000 ft^3 – 3676.2 ft^3 = 110,324 ft^3

Flammable gas concentration in the tank headspace
= Volume of flammable gas / Volume of tank headspace
= 3676.2 ft^3 / 110,324 ft^3 = 0.033
= 3.3 % hydrogen.

This concentration is less than the 4 percent hydrogen in air which is the LFL.

Similarly, using more realistic but still bounding assumptions from above, we calculate:

Volume of flammable gas = Volume of solids * hydrogen fraction
= 9000 gallons * 0.60 hydrogen fraction * 0.13368 ft^3/gal
= 722 ft^3 hydrogen

Flammable gas concentration in the tank headspace
= 722 ft^3 hydrogen * 0.5 release fraction / 110,324 ft^3 total gas in the headspace
= 0.00327 = 0.327 % hydrogen or less than 9 % of the LFL.

These results may be compared with the LFL for hydrogen of 4 percent in air.

6.0 CONCLUSION

Neither steady state nor gas release event conditions can render the C-106 tank headspace flammable. Using reasonable assumptions the calculations show that the tank cannot even achieve 25 percent of the LFL.

Although more sophisticated calculation methods including Monte Carlo analysis of variability are being employed to evaluate gas release events in tanks for the Documented Safety Analysis, given the

large margin shown in the above calculations these methods are not required to conclude that the tank cannot achieve a flammable atmosphere.

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