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HAZARDS RESEARCH CORPORATION

Fire and Explosion Hazards Evaluation

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December 21, 1976

Mr. Clement M. Walker
Atlantic Richfield Hanford Company
Federal Building
Richland, Washington 99352



Dear Mr. Walker:

Thank you for the hospitality afforded me on my recent visit to Atlantic Richfield Hanford Company. During that visit we discussed the problems associated with chemical milling to penetrate the bulge in the liner in Tank 105-A. This letter will serve to confirm my comments and recommendations which were not formally recorded at that time.

A. Introduction

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Tank 105-A underwent a severe steam release in January of 1965 at which time the bottom liner bulged creating a captured volume of some 30,000 gal. between the bulged liner and the concrete pad. In order to dismantle the liner safely it is necessary to avoid a vapor phase explosion in the bulged volume or in the tank itself. Since the composition of the trapped gases is not known the concern is whether or not the penetration of the liner can be made safely.

B. Composition of Trapped Vapor.

The information currently available (Ref. 1) indicates that the radiolytic gas environment might be rich in hydrogen and may not contain oxygen. Even oxygen originally present in the reported experiments was consumed in some oxidative process. Thus a best estimate of the composition of the trapped gases is that they consist mainly of hydrogen.

However, the possibility exists that over extended periods of radiation (10 years is the lifetime of the vapor space in the bulge) oxygen which is formed from the radiolysis of water may eventually begin to accumulate. Thus the "worst case" assumption for the composition of the trapped gases is that they are a stoichiometric mixture of hydrogen and oxygen produced by the radiolysis of water.

C. Damage Potential

Assuming the worst case assumption, that the trapped gases consist of a mixture of hydrogen and oxygen, then the possible consequence of combustion are as follows:

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a. Deflagrative combustion in the 30,000 gal. bulged section would fail the liner and produce a steady pressure of between 9 to 9.5 psig on the tank dome.

b. Detonative combustion would produce a shock of approximately twice that intensity (i. e. 18 to 19 psi) on the dome. Such a load would fail the dome and scatter radioactive material.

The electrical spark energy required to ignite an oxygen-hydrogen mixture is 0.001 millijoules, an exceedingly small value. The role of the spark is to produce ions or atoms which initiate the chain branching process resulting in propagating flames. Since hydrogen-oxygen systems ignite so readily it could be anticipated that the energy available (in terms of the chemical potential of the stream due to the presence of ions, radicals and high energy surfaces) during the chemical milling process with nitric acid may be sufficient to ignite them.

Assuming that the trapped gas is essentially hydrogen, then the introduction of an oxidizing atmosphere (HNO_3 , NO_2 , NO , O_2 etc.) even in small quantities could cause local ignition under the bulge. While such local ignition per se would not cause sufficient pressure to fail the tank. It would cause an increased pressure and so some of the trapped gas would flow from below the bulge into the tank where it could mix with air. The combustion of a volume of gas, originally occupying as little as 3 to 5% of the tanks volume would be sufficient to fail the head. This is based on the fact that the expansion ratio for hydrogen-oxygen combustion is between 7 and 8. A combustion in 1% of the tank would increase the pressure by 1 psig, in 5% of the tank by 5 psig and in the entire tank by about 100 psig.

In the one million gallon tank the minimum quantity of hydrogen needed to produce a pressure of 5 psig is 2150 cu. ft. The quantity of oxygen required to oxidize it completely is 1075 cu. ft.; air is 5000 cu. ft. and nitric acid is 150 pounds as HNO_3 .

D. Summary and Conclusions

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While it is not at all certain that a mixture of hydrogen and oxygen exists in the void space between the liner and concrete base this assumption is made since it represents a worst case. Such a mixture is very sensitive, and the probability of ignition even by the chemical milling process is great enough so that it constitutes an unacceptable risk in view of the consequences of an error.

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On the other hand if it could be demonstrated that the assumption of oxygen present below the liner is not a credible one then the penetration through the top could be made if the quantity of oxidizer in the tank is limited. The quantity of oxygen should be limited to 1000 cu. ft., the amount in 5000 cu. ft. of air and the HNO_3 should be limited to 150 lbs.

In view of the fact that it is not possible to know the composition of the gases in the bulged area until after penetration is made, the penetration as proposed constitutes an unacceptable risk. It is recommended that alternate methods of penetration be studied. For example, penetration below an aqueous surface would eliminate the risk of ignition. It is recognized that adding water to the tank poses the problem of leaching radioactive elements into the soil. This adverse effect would have to be balanced against the risk of air borne contamination due to a vapor explosion.

I hope these remarks will be useful to you. If you have any questions please call me.

Sincerely,

HAZARDS RESEARCH CORPORATION

Chester Grelecki

Chester Grelecki, Ph. D.
Chief Scientist

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Reference 1. "Radiolytic Gas Generation in Plutonium Contaminated Waste Materials", Armen R. Kazanjian, Rockwell International, Atomics International Division, Golden, Colorado, RFP-2469, October 29, 1976