Department of Energy
Washington, DC 20585

February 21, 1996

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, D.C. 20004

Dear Mr. Conway:

Your letter of January 22, 1996, to Assistant Secretary Grumbly, focused our attention on risks associated with radiolytic generation of hydrogen in tanks and pipes at Rocky Flats. The action plan for addressing these concerns is enclosed as requested. Characterization and purging of high fissile content tanks in Building 771 have provided an increased margin of safety. While we continue to improve upon these efforts, we are turning our attention to characterization and purging of the lower fissile content tanks in Building 371 and to potential for pressurization of isolated piping. We have incorporated performance incentives for aggressively instituting this hydrogen safety plan in facility operating and management contracts.

We are further reducing potential hazards by eliminating flammable gases in adherence to code and best practices. Programs are in place to assure that appropriate controls are included in procedures for maintenance and operating activities. Additional and more detailed information have been provided to your staff members at the Rocky Flats site. Updates and changes to the enclosed action plans will be distributed to them informally when approved.

This information is unclassified and suitable for placement in the public reading room.

Sincerely

W. W. [signature] for
Richard J. Guimond
Assistant Surgeon General, USPHS
Principal Deputy Assistant Secretary
for Environmental Management

Enclosure

PLAN OF ACTION (POA)

MITIGATION OF RISKS FROM RADIOLYTICALLY GENERATED HYDROGEN IN TANKS AND PIPING SYSTEMS AT ROCKY FLATS

REV. B

February 14, 1996

Background

In October 1993, Los Alamos Technical Office performed an initial analysis of radiolytically-generated hydrogen and concluded that, while hydrogen gas was being generated in aqueous actinide solutions, it was not a safety concern if tanks remained vented. Subsequently, DOE requested the contractor to verify vent lines were open. This led to initiation of an Unreviewed Safety Question Determination (USQD) for Building 371 and Building 771, where the majority of aqueous actinide solutions are stored. Engineering calculations predicted a number of tanks in both buildings which could collect explosive levels of hydrogen. Further calculations for hydrogen generating tanks predicted that even vented tanks could generate significant explosive mixtures of H_2 and O_2. This led to a sampling program in Building 771 to obtain data from the highest predicted hydrogen generating potential tanks in order to obtain field data for comparison to the analytical results.

Concurrently, Nuclear Safety determined that the H_2 represented a discovery Unreviewed Safety Question (USQ) as an accident of a new type, and an occurrence report was filed. The USQ did not identify an increased risk to the public. Buildings 771 and 371 took action to limit personnel access in areas with H_2 generating tanks as well as eliminating ignition sources and unnecessary activities as a worker safety compensatory measure.

Requirement

A formalized Hydrogen Safety Control plan has been established by Engineering Integration based on the following requirement:

> Hydrogen levels must be maintained at or below 25% of the Lower Flammability Limit (LFL) in air (1% hydrogen by volume) as defined by the National Fire Protection Association (NFPA): National Fire Codes Standard 69, Explosion Prevention Systems, Chapter 3: Combustible Concentration Reduction, Section 3-3.1, 1992 edition.

The plan was issued on February 6, 1996.

In addition to the NFPA limit, Engineering Integration calculations include a TNT gram equivalent explosion potential for tanks. This value accounts for the void space volume and is used to assist in prioritizing tanks which contain hydrogen levels above 1% by volume.

A team of engineering and operations personnel will visit the National Space Technical Laboratory in Gulfport, Mississippi in February, 1996 to review the hydrogen safety precautions employed by the space program. Any lessons learned will be incorporated into the Hydrogen Control Safety Plan to further reduce worker safety risks.

Building 771 Status

Building 771 was initially targeted for the sampling and elimination of hydrogen due to the relatively high concentrations of actinide solutions present in this facility. Operational controls including limiting access, prohibition of welding and grinding, and elimination of ignition sources, were established throughout the facility. These controls were instituted via Technical Operations Order. The void spaces of ten of the most susceptible tanks (i.e., those with the highest predicted levels of H_2 flammability potential) were sampled to establish levels of hydrogen. Five of the tanks contained no hydrogen and were subsequently verified to be operationally empty. The other five tanks had concentration levels similar to those predicted by engineering calculation. Using an apparatus designed for void space sampling and purging, these five tanks were purged with argon and re-sampled to determine both the effectiveness of the purge process and to establish generation rates and equilibrium accumulation values. The highest concentration tank exhibited a generation rate high enough to reach the Lower Flammability Limit (LFL) for H_2 in a matter of hours following an argon purge. The five tanks were placed on a continuous air purge such that hydrogen levels were maintained below the LFL. Two tanks are currently slightly above the 1% limit. An engineering design modification to the sample/purge apparatus is underway to allow increased airflow to further reduce the hydrogen to below the NFPA limit. This will be discussed as a specific task in this plan. Clearly, the results from the Building 771 hydrogen sampling pilot program confirmed analytical predictions that radiolysis can cause significant H_2 accumulation even in vented tanks unless susceptible tanks are periodically purged and ultimately drained.

As discussed above ten tanks in Building 771 with the highest potential to accumulate H_2 have been sampled and purged to reduce H_2. In all but three of these (whose concentration is currently about 2% H_2) the levels have been reduced below the NFPA limit. Sixty six additional tanks are predicted to contain H_2 in excess of 1% by volume, although several of these are known to be operationally empty and may contain no H_2. The tasks prescribed below for Building 771 target these remaining sixty six tanks by sampling, purging as required, and developing a long term hydrogen maintenance plan for each tank.

Building 371 Status

Analytical predictions for hydrogen levels in Building 371 tanks have been conducted using the model and empirical data derived from Building 771. No actinide tank void space sampling has been performed in Building 371 to date. Building 771 tanks were the initial focus of the sample/purge efforts since actinide concentrations in Building 771 are significantly higher than in Building 371 (maximum concentration in Building 371 is 9 g/l Pu). Further, Building 371 tanks are more difficult to sample/purge as the rooms containing susceptible tanks require extensive personnel protective equipment for entry because of surface and airborne radiological contamination.

Building 371 contains 8 tanks which, by calculation are predicted to generate levels of hydrogen above the NFPA limit. Facility management has instituted similar operational controls for worker safety as described for Building 771, including limiting access, prohibition of welding, and elimination of ignition sources in the vicinity of susceptible tanks. Most of the tanks in Building 371 are accessible only with supplied breathing air protection which has complicated sampling efforts. However, a similar approach to that used in Building 771 will be undertaken in Building 371. Each tank will be sampled, purged if required, and a hydrogen maintenance regimen will be established for each tank. As in Building 771, the hydrogen maintenance regimen for each tank will be based on sample and purge data, radiolytic generation rates, and will be coordinated with tank draining activities.

Analytical Results

An analytical model has been established which predicts the level of radiolytically produced hydrogen in tanks for given actinide concentrations, void space volumes and solution acidity. Further, a purge gas flow rate which will maintain the hydrogen concentration below the NFPA limit in the solution tank head space is predicted. Additionally, solution evaporation rates have been evaluated to ensure that purging does not increase evaporation rates sufficiently to cause solution concentrations to exceed the Nuclear Material Safety Limits (NMSLs). This model has shown excellent agreement with empirical data derived from the Building 771 sampling and purging effort and will be used as a decision making tool in the Building 371 effort. The analytical model was prepared by Dr. Robert Colwell and is documented in a formal engineering calculation.

A peer review of the analytical model and related work is being conducted by Dr. Harold Schwarz of the Brookhaven National Laboratory. He will review the engineering calculations for technical accuracy with special emphasis on the validity of the methodologies used for determination of radiolytic gas generation rates in the vessels as a function of time. He will also provide literature available to him which is appropriate to our ongoing study of radiolytic flammable gas generation in organic tanks and pipes. A formal report will be delivered by Dr. Schwarz and suggested changes in the computational models will be incorporated if they are judged necessary and appropriate for accuracy of model predictions.

Status of Hydrogen Accumulation USQD

On May 16, 1995, USQD-RFP-0387-CAS was transmitted to the Department of Energy, Rocky Flats Field Office (DOE, RFFO) summarizing the risk associated with hydrogen generation in actinide solution tanks. The conclusion of the USQD was that the potential hydrogen build-up in actinide solution tanks is a discovery issue that represents an accident of a different type and consequently an Unreviewed Safety Question (USQ). No increased risk to the public was identified. In Building 771, nuclear safety calculations for the Maximum Offsite Individual (MOI) dose were based on the explosive potential in tanks which were assumed to be passively vented to prevent pressure build-up. In Building 371, the nuclear safety calculations for the MOI dose were performed assuming non-vented tanks. Building 371 tanks were assumed to be non-vented due to the inaccessibility to rooms to conduct vent valve position verification. While it is believed that the susceptible tanks are in fact passively vented the more conservative case was assumed until actual vent valve position status is independently verified. The vent valve positions will be verified during the Building 371 H_2 mitigation activities.

Strategy

The strategy used to manage the generation and accumulation of hydrogen in actinide solution tanks is to identify tanks which pose a hydrogen accumulation hazard, establish strict work controls, sample the susceptible tanks, purge if required, and then establish a hydrogen maintenance regimen until the tanks can be drained. This approach is outlined in the following tasks for Building 371 and Building 771. No other buildings have been identified with aqueous actinide solutions in tanks or pipes.

The priority in which tanks are sampled and purged will be based on three criteria: predicted hydrogen level, calculated TNT equivalent value, and accessibility of the tank. Clearly the strategy is aimed at purging hydrogen from the tanks with the highest hydrogen and TNT gram equivalent levels first. However, in rooms which contain high airborne and surface contamination levels which require extensive personnel protective equipment, it may be appropriate to purge all susceptible tanks in that room in one effort in order to minimize worker radiation exposure. Other operational considerations may dictate the order in which tanks are purged such as concurrent risk reduction activities (i e., tank draining) which may result in purging a somewhat lower risk tank to reduce the risk prior to draining.

Two additional areas of concern will be addressed in this plan after the Building 771 and Building 371 tanks listed above have been mitigated. The first includes the identification and disposition of piping systems which may have the potential to generate hydrogen. Initial steps have been taken to identify suspect piping systems in Buildings 771 and 371. Steps will be listed in this plan to formally identify suspect pipes, include the pipes in appropriate engineering calculations, and then appropriate work packages will be developed to sample and purge (if required). The second area of concern includes the identification and disposition of tanks and pipes containing spent organic solvents which may have the potential to radiolytically decompose and generate hydrogen. Engineering calculations have been initiated to model generation in these types of solutions. Once identified, sampling, purging and a hydrogen maintenance regimen will be established for organic tanks and pipes, as appropriate, where hydrogen levels exceed NFPA limits.

BUILDING 771 ACTINIDE SOLUTION TANKS

Task	Subject	Task Manager	Milestone Due Date
1	Complete Baseline Change Proposal (BCP) to establish funding for this effort	J. Garmatz	Complete
2	Develop a tank database to facilitate management of tank status using the following information: Predicted H_2 levels Actinide concentrations Void space sample results (H_2) Sampling/purging status STATUS including IWCP performance, walkdowns, sampling results, etc. This database will be used to prioritize (based on criteria discussed) and status the progress of sampling and purging activities.	F. E. Gibbs	March 1, 1996
3	Of the remaining 66 tanks in Building 771 with predicted H_2 concentrations in excess of 1% by volume (calculation 95-SAE-030), sample 10 of these tanks for H_2. The 10 tanks selected will be prioritized based on predicted H_2 levels, TNT gram equivalent, and accessibility with a clear preference for mitigating the highest risks first.	S. M. Sax	Tank 1 start April 8, 1996 5 tanks April 25, 1996 10 tanks May 6, 1996
4	Purge tanks shown to contain > 1% H_2 by volume and re-sample as necessary.	S. M. Sax	Tank 1 start April 10, 1996 5 tanks April 29, 1996 10 tanks May 13, 1996
5	**Sample 28 additional tanks identified in engineering Calculation 95-SAE-030.**	**S. M. Sax**	**September 30, 1996**
6	Establish H_2 maintenance plan for each tank. This may include a 1-time purge, periodic purging, or continuous purge based on sampling and analytical modeling.	S. M. Sax	Task start June 1, 1996 Task complete **September** 30, 1996
7	Establish performance measure and schedule for sampling and purging remaining tanks.	G. Tasset	April 1, 1996
8	Sample remaining tanks identified in Engineering calculation 95-SAE-030	S. M. Sax	October 30, 1996
9	Purge tanks shown to contain >1% H_2 by volume and re-sample as necessary.	S. M. Sax	November 15, 1996
10	Establish H_2 maintenance regimen for each tank. This may include a 1-time purge, periodic purging, or continuous purge based on sampling and analytical modeling.	S. M. Sax	December 6, 1996

BUILDING 371 ACTINIDE SOLUTION TANKS

Task	Subject	Task Manager	Milestone Due Date
1	Complete Baseline Change Proposal (BCP) to establish funding for this effort	J. Garmatz	**Complete**
2	Develop a tank database to facilitate management of tank status using the following information: Predicted H_2 levels Actinide concentrations Void space sample results (H_2) STATUS including IWCP performance, walkdowns, sampling results, etc. This database will be used to prioritize (based on criteria discussed) and status the progress of sampling and purging activities.	F. E. Gibbs	March 1, 1996
3	Sample 8 tanks identified in Engineering Calculation 95-SAE-030 as containing hydrogen levels above NFPA limit. Note: To provide flexibility, sampling may be conducted subsequent to purging and/or sparging depending on previous sample results, tank system configuration, radiological considerations, etc.	**W. Stephens**	Tank 1 : April 1, 1996 50% tanks: May 15, 1996 100% tanks: June 30, 1996
4	Purge tanks shown to contain > 1% H_2 by volume and re-sample as necessary.	**W. Stephens**	Tank 1: April 4, 1996 50% tanks: May 20, 1996 100% tanks: June 30, 1996
5	Establish H_2 maintenance plan for each tank. This may include a 1-time purge, periodic purging, or continuous purge based on sampling and analytical modeling.	**W. Stephens**	Task start June 1, 1996 Task complete July 15, 1996

ACTINIDE PIPING WITH THE POTENTIAL FOR HYDROGEN ACCUMULATION

Task	Subject	Task Manager	Milestone Due Date
1	Promulgate a list of piping runs in Building 371 and 771 with a high potential for accumulating hydrogen in excess of the NFPA limit.	R. Colwell	February 22, 1996
2	Walkdown high potential piping runs to determine isolation boundaries and vented status. **Walkdown 2 known high potential piping runs in Building 371.**	A. Eden (771) K. Serafin (371)	March 15, 1996 (B771) **April 15, 1996 (B371)[2]**
3	For high potential piping runs which are determined to be isolated (i.e., not vented) promulgate a venting method.	D. Hepler	March 28, 1996(B771) TBD (B371)[2]
4	Sample a minimum of three high potential piping runs for hydrogen between Building 371 and 771 to better characterize the extent of the problem.	S. Sax (771) **W. Stephens (371)**	TBD (B771)[3] TBD (B371)[2]
5	Based on sample results, develop a Plan of Action to mitigate hydrogen in piping runs.	F. Gibbs	TBD(B771)[3] TBD (B371)[2]
6	Establish performance measure for mitigation of hydrogen in actinide piping.	G. Tasset	(B771)[3] TBD (B371)[2]

Note 1: Funding for initial characterization of piping systems will be covered by the scope of sampling and purging for tank systems. Initial estimates for the BCP were for tanks only, but these cost estimates were conservative and recent data suggests that some tanks will not have to be sampled because they may be empty. As a result, funding is expected to be available from this work package. If, after initial characterization it is determined that additional funding is required, an additional BCP will be prepared and submitted for approval.

Note 2: Additional dates will be determined following receipt of task 1 information for B371. **The plan will be updated by April 30 to reflect these dates. Piping runs in Building 371 are located in areas with limited access. In addition, reliable information regarding pipe contents is unavailable. No reliable estimates of pipe runs of concern can be provided.**

Note 3: This date will be determined following receipt of task 3 information for B771. **The plan will be updated by April 15 to reflect this information. Preliminary data indicates five piping runs in Building 771 are of concern.**

SPENT ORGANIC TANKS WITH THE POTENTIAL FOR HYDROGEN ACCUMULATION

Task	Subject	Task Manager	Milestone Due Date
1	Promulgate a list of spent organic solvent tanks in plutonium buildings with a high potential for accumulating hydrogen in excess of the NFPA limit.	R. Colwell	March 4, 1996
2	Complete Baseline Change Proposal (BCP) to establish funding for this effort (if required)	J. Garmatz	March 15, 1996
3	Establish performance measure for mitigation of hydrogen in spent organic tanks.	G. Tasset	March 15, 1996
4	Walkdown high potential organic solvent tanks to determine isolation boundaries and vented status. Disposition spent organic tanks for each building which contains suspect tanks.	A. Holifield (707) W. Franz (776/777) S. Miller (779) D. Hunter (559) S. Sax (771) K. Serafin (371)	Commence NLT March 15, 1996 for Buildings 707, 559, 776/777, 779[2] B371, B771 TBD[2]
5	For high potential organic solvent tanks which are determined to be isolated (i.e., not vented) promulgate a venting **method.**	TBD	TBD **(Task 4 completion + 45 days)**
6	Sample a minimum of three high potential organic tanks for hydrogen to better characterize the extent of the problem.	TBD	TBD **(Task 4 completion + 30 days)**
7	Based on sample results, develop a Plan of Action to mitigate hydrogen in **organic** tanks.	TBD	TBD **(sample completion + 30 days)**

Note 1: Task managers and completion dates will be determined based on information from Tasks 1,2, and 3.

Note 2: Disposition/walkdowns of spent organic tanks in buildings other than 371 and 771 will commence no later than March 15, 1996. The initial focus in Buildings 371 and 771 will concentrate on mitigating H_2 in aqueous actinide solution tanks after which spent organics will be addressed. A **date for commencement will be provided by June 15, 1996.**

ENGINEERING CALCULATION PEER REVIEW

Task	Subject	Task Manager	Milestone Due Date
1	Conduct peer review of engineering calculations and issue formal report of recommendations.	Dr. Schwarz	March 29, 1996
2	Incorporate Dr. Schwarz's recommendations (as appropriate) into engineering calculation.	R. Colwell	April 19, 1996