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ROCKWELL INTERNATIONAL
ATOMICS INTERNATIONAL DIVISION
ROCKY FLATS PLANT

TANK STUDY COMMITTEE REPORT

February 25, 1977

Tank Study Committee Members:

C. L. Schuske	- Nuclear Safety (Chairman)
A. Benjamin	- Quality Engineering and Control
R. H. Karlsson	- Chemistry R&D
D. G. Mason	- Facility Engineering and Construction
E. A. Putzier	- Health Sciences and Industrial Safety
E. M. Sitzberger	- Operational Safety Engineering and Fire Protection
E. Vejvoda	- Chemical Operations
D. A. Wiederecht	- Research and Development

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Alternate Members:

W. C. Bright	- Component Development
K. W. Calkins	- Engineering/Technical Support
L. W. Doherty	- Chemistry Standards Laboratory
D. L. Gally	- Mechanical Design
G. L. Hickie	- Mechanical Design
C. R. Johnson	- Health Sciences
W. D. Kittinger	- Engineering and Safety Analysis
J. D. McCarthy	- Criticality Engineering
R. J. Merlini	- Component Development

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ERDA Contract No. EY-76-C-04-35-33

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Distribution:

A. Benjamin
K. W. Calkins
D. J. Cockeram
L. W. Doher
D. L. Gally
G. L. Hickie
C. R. Johnson
R. H. Karlsson
W. D. Kittinger
D. G. Mason
J. D. McCarthy
R. J. Merlini
E. A. Putzier
C. L. Schuske
W. M. Shannon
E. Vejvoda
R. E. Yoder
D. A. Wiederecht
R. O. Williams

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ABSTRACT

Six major problem areas have surfaced in the past twenty-five years concerning the use of plutonium tankage. The most significant of these involves the use of borosilicate glass as a neutron absorber.

Approximately thirty recommendations and criteria resulted from a study of these problem areas. Not all of the criteria and recommendations are unanimously supported by all members of the committee. The committee agrees that problem areas that can be handled on a short-term basis are being pursued expeditiously. Most of the criteria presented will apply to new tankage to be installed.

The committee also noted fourteen accomplishments in the last $1\frac{1}{2}$ years directed to the application of the criteria.

INTRODUCTION

A plutonium tank study group was appointed by R. E. Yoder and D. A. Wiederecht on September 3, 1976. The purpose of the study group is to provide criteria for the design and use of plutonium tankage. This group is composed of engineers and other technical personnel representing the following disciplines: Health, Safety, and Environment; Research and Development; Quality Engineering and Control; Facilities Engineering and Construction; and Chemical Operations. Thirteen meetings of this committee were held between September 3, 1976, and January 28, 1977. The agendum of these meetings covered the following subjects:

A. Criteria for Tank Applications

1. Safe geometry tanks
2. Raschig-ring-filled tanks

B. Tank Design

1. Features of safe geometry tanks
 - a. Shape of tank
 - b. Tank connections
 - c. Filtration
 - d. Sampling
 - e. Inspection methods
 - f. Mixing
 - g. Cleaning methods
2. Features of Raschig-Ring-Filled Tanks
 - a. Shape of tank
 - b. Location of ports
 - c. Tank connections

- d. Filtration
 - e. Sampling of solution
 - f. Sampling of rings
 - g. Calibration method
 - h. Mixing of solution
 - i. Ring screening
 - j. Ring filling and removal devices (baskets, etc.)
- C. Raschig Rings
- 1. Specifications of rings
 - 2. Purchasing
 - 3. Inspection (initial and reinspection)
 - 4. Auditing of inspections
- D. Cleaning and Removal of Tanks
- 1. Safety analysis and operating procedures
 - 2. Equipment (Operations and Health & Safety)
- E. Processing Rings
- 1. Recovery of material from sludge
 - 2. Recovery of material from rings
- F. Disposition of Tank and/or Rings
- 1. Packaging
 - 2. Shipping method

Most of the committee's efforts involved discussions concerning borosilicate glass (pyrex-type) as a nuclear absorber in large tankage. This route of solution storage was taken at the Rocky Flats Plant in 1959 primarily for economic reasons. Conventional chemical tankage was filled with borosilicate glass rings. No operating experience was

available for this mode of storage. Many of the problems that have developed over the past seventeen years were not predicted. Some of the areas needing attention apply to all types of tankage, while others are specific to Raschig-ring-filled vessels.

GENERAL POLICY STATEMENT

All new tank designs shall be approved by authorized personnel representing Health, Safety, and Environment; Research and Development; Quality Engineering and Control; Facilities Engineering and Construction; and the user organization. To the extent possible, recommendations given in this report shall provide guidance. These authorized personnel shall also approve the appropriateness of the tank type for a specific application.

PROBLEM AREAS

The committee identified six major problem areas for plutonium tankage. Several of these have received considerable attention, and others are being pursued. The following is a list of these problem areas with additional comments.

A. Raschig Rings

Several problems concerning Raschig-ring-filled tanks are:

1. Loading of rings into tanks exposes personnel to industrial safety hazards as well as radiation hazards. In addition, improper loading can increase breakage, result in incomplete filling, and contribute to formation of voids.
2. Removal of rings from tanks exposes personnel to industrial safety and radiation hazards.
3. Inspection of the ring level in a tank, or removal of sample rings for inspection, requires an adequate number of properly-sized ports (nozzles). Performance of these inspections requires removal of the ports, which can cause radiation and contamination problems. In addition, assurances are needed that the sample rings removed for inspection are not previous replacement rings and that there is enough accessibility to provide an adequate supply of ring samples.
4. Settling of rings can cause problems by forming voids in the top of the tank. This can be due to breakage

of the rings or a compaction of the rings. Also, this change in ring distribution can adversely affect volume calibration.

5. Integrity of the rings. Ring deterioration can cause nuclear safety concerns. Failure to meet ring specifications can cause breakage, reduce the percent glass volume occupied by the rings, and provide inadequate neutron poisoning (B_2O_3 content). The replacement of these rings will cause problems associated with the ring removal and refilling operations.

B. Gaskets

Gaskets for pipe flanges as well as tank nozzles have led to plutonium leaks which present contamination control problems. The problems include cold flow for certain gasket materials and improper torquing of bolts. Improperly cleaned flanges also have led to leaks.

C. Sludge

Sludge build-up in all types of tanks and on Raschig rings presents volume calibration problems, as well as risks from a nuclear safety standpoint. Several problem areas are: preventing sludge materials from forming, pre-filtering of feed lines to remove sludges, sludge removal from tanks, and in situ determination of sludge deposits.

D. Mixing and Sampling

Mixing and sampling of solutions is a problem area affecting operations, nuclear safety, and the accountability of nuclear materials.

E. Contamination Control

Contamination control becomes a problem whenever tank cleaning, inspection, or general maintenance on tanks and related piping is necessary.

F. Calibration

The accurate volume calibration of tanks is needed for both accountability and process control purposes, and also for nuclear safety purposes to assist in the detection of sludge accumulations and the presence or absence of rings. The problems associated with calibration can be minimized by judicious selection of the tank shape and other features and improving the instruments used for calibration.

RECOMMENDATIONS AND CRITERIA

A. Raschig-Ring-Filled Vessels

For loading of new rings and removal of used rings, tank designs can follow two separate approaches depending on the application.

Tanks with flat or dished fully-bolted tops could be designed to provide complete access to the interior of a tank. These tanks could be filled directly with rings or contain perforated steel baskets which would be ring filled (Raschig ring cartridges). These cartridges would be withdrawn from the tank when rings need cleaning or replacement. A vibrator should be used on these cartridges to compact the rings. This compaction would be done outside of the tanks.

Another approach would be to provide sufficient 8"-diameter or larger nozzles, spaced no greater than 18" on the tank top, for ring filling. Vibrators would be attached to the tank for compaction.* However, the tank would need to be detached from the piping to preclude loosening of pipe connections, causing leaks.

Periodic ring inspections would be accomplished in the first case, where cartridges (baskets) are used, by removing the baskets (probably a stacked arrangement of

* NOTE: The tank, tank supports, and floor loading designs shall reflect the additional load caused by the vibrators.

shallow baskets) and selecting rings from the appropriate baskets. Replacement rings would be tagged to preclude their use on the next sampling.

In the second case, where baskets are not in use, it is recommended that the rings be removed from bottom ports or from stringers reaching into the interior of the tank. Sufficient stringers would be used to provide samples over the life of the rings.

A mechanical auger, under development by R&D, for ring removal appears promising. Bottom ports (nozzles) should be at least 6" in diameter to accomodate the auger. These ports should be inclined upward at an angle of 5° from the horizontal. Tanks of 4' diameter and smaller should have one such port. Larger tanks should have three ports spaced approximately equally around the tank. As far as practical, a clearance of 4' should be maintained in front of the flange face. Tank interiors should be free from internal piping and obstructions to the maximum extent possible. Tanks should be spaced in a manner to permit at least 24" to 36" of clearance between tanks to permit clearance for the general maintenance work. At least 18" of clearance from the floor to the bottom of a tank or nozzle, whichever is lower, should be allowed to permit maintenance activity. Process liquids should normally be withdrawn from the bottom of the tank.

B. Gaskets

Although several problems have emerged, these are under control. However, we recommend that written procedures be developed for proper torquing of bolts to minimize excessive judgment in this operation. Facilities Engineering and Construction, working with R&D, should provide these criteria. These groups should also recommend R&D efforts on new gasket materials that might be needed, as well as procedures for the selection and use of existing materials.

C. Sludges

The committee recommends that the four problem areas discussed in item C of the previous section (page 10) receive considerable R&D attention.

Sludge formation occurs primarily from the dissolution of incinerator ash. When burning temperatures are high, high-fire oxides result and are difficult to dissolve. R&D should investigate burning temperature vs dissolution rate for the oxide, or an alternate recovery process to minimize these oxides.

R&D should review and develop improved prefiltration methods and filter media for feed streams in order to remove fine particles from these feed streams.

Improved instrumentation should be developed by R&D to provide better quantitative in situ determination of sludge deposits in all vessels.

D. Mixing of Solutions Within the Tank

For Raschig-ring-filled vessels and annular tanks, a mixing ring near the tank top external to the tank and ported into the tank in at least six locations would permit good mixing of the solution to assure representative sampling and temperature measurements. Solution would be drawn from the bottom of the tank and then pumped to the mixing ring for dispersal. This should be done in such a manner as to minimize the entrainment of liquids into the vacuum or vent systems. This approach would not be necessary for pencil tanks. The committee recommends that further work be done by R&D on mixing dynamics.

E. Contamination Control

A joint effort by Health Sciences personnel working with R&D, Engineering, and Operations is needed to develop better methods for controlling contamination.

The R&D ring removal auger appears to be one such approach. Few ideas were evolved in this area by the present committee.

F. Calibration

The principle concern is in the area of SS material accountability, and the secondary concern is in the area of nuclear safety. Process control measurements are also important. The following are recommendations.

1. Direct reading sight gauges*, such as the Jurguson type, should be installed on all tanks including pencil, annular, and Raschig-ring-filled. A stable reference pad should be located beneath the sight gauge for calibration.

2. A connection with a check valve and manually-operated shut-off valve should be provided at the top of the tank for calibration purposes. Valves and sight gauges should be installed in such a manner as to permit determining the volume in each tank separately from others.

3. All tanks shall be vertical, and preferably cylindrical, and of all welded construction.

4. Connections provided for tank calibration liquids should be located on external piping, above the working level of liquid in the tank. A portion of the connections should include temperature sensing probes in the mixing systems described under D (page 15).

5. Where instrumentation is associated with the tank to provide remote and/or automatic operation, the instrumentation should be separated by valves to facilitate maintenance and calibration.

G. Miscellaneous Recommendations

1. Geometrically-Unsafe (Poisoned) Tanks

Geometrically-unsafe (poisoned) tanks should be used only in those services in which the volume requirements

* However, it is recognized that certain applications may require other approaches (i.e., corrosive liquids would damage glass gauges, etc.).

make the use of geometrically-safe tanks impractical. They should not be used for services in which the solution concentration reasonably might exceed 100 grams of plutonium per liter, and where the solution to be stored contains solids or corrosive materials.

2. Geometrically-Safe Tanks

Geometrically-safe tanks, such as pencil or annular, should be used for all services in which the solution concentration exceeds (or reasonably might exceed) 100 grams Pu per liter. Where practical, they should be used in services in which the solution concentration exceeds (or reasonably might exceed) 30 grams Pu per liter.

ACTION ITEMS AND ASSIGNMENTS

The following list contains action items and the recommended assignments for each item.

A. Raschig-Ring-Filled Vessels

1. Overall tank design is the responsibility of the user organization and the Facilities Engineering and Construction Department.

2. Ring compaction procedures and hardware shall be developed by R&D.

3. Ring removal hardware shall be developed by R&D.

B. Gaskets

Gasket selection and procedures for use of materials shall be the responsibility of R&D and Facilities Engineering, working with the user organization and Maintenance.

C. Sludges

A Research and Development effort is recommended on the problems of sludge formation, alternate chemical methods, and filtration of feed streams. Better quantitative methods for the in situ determination of sludge is recommended.

D. Mixing of Solutions Within Tanks

It is recommended that R&D work be done on mixing dynamics. Hardware and procedures shall be developed by R&D, working with Facilities Engineering and QE&C.

E. Contamination Control

Health Sciences, R&D, Facilities Engineering, and the user shall develop improved contamination control methods and procedures.

F. Calibration

Calibration hardware shall be mutually developed by Facilities Engineering and the Standards Laboratory, and procedures for the use of the hardware shall be the prime responsibility of QE&C.

ACCOMPLISHMENTS

Since most of the tankage used at Rocky Flats is borosilicate Raschig-ring-filled, the accomplishments over the past 1½ years are improvements to this type of tankage.

These include:

- A. Continued progress in adding additional ports (nozzles) to the tanks to aid in removal of rings, observation of ring levels, and filling.
- B. Exchanged the smaller 4"-diameter nozzles for 6" nozzles for the above reasons.
- C. Developed a new Rocky Flats Plant Standard (SX-106) purchase specification so that new rings on order would be of better tempering quality and size.
- D. Improved the analytical sampling plan to better ascertain the quality of new and used rings.
- E. R&D has designed an auger* for ring removal which is now being tested.
- F. Facilities Engineering is accumulating information for a tank characteristics chart for all Raschig-ring tanks at Rocky Flats.
- G. A tank inspection group is in operation whose duties include filling and removal of Raschig rings and the routine inspection of all tanks for all areas of Rocky Flats.

* The auger has been tested only on the removal of clean rings as of this date (February 25, 1977).

H. All tanks are now on an inspection schedule, and files are kept on all tanks (safe as well as Raschig-ring-filled vessels).

I. Responsibilities for Raschig-ring-filled vessels have been delineated in HSE 19.01.

J. Expansion of gamma scanning for fissile sludge accumulations in all types of tankage has been done (more needs to be done).

K. Criticality calculations were done on accumulation of sludge as a function of reactivity of a tank of solution.

L. Improved calibration data presentation and compilation has been developed.

M. R&D studies have been done on Raschig-ring compaction with vibrators attached to the tank exteriors.

N. Limited R&D studies have been done on solution mixing using a mixing ring internal to a Raschig-ring-filled tank.

CONCLUSIONS

It is the committee's opinion that changes that can be accomplished on a short-term basis have been or are being implemented. Consequently, the criteria and recommendations presented in this report primarily apply to new tankage or for new plants.

New concepts for poisoned vessels were also discussed; however, considerable planning and calculations, as well as critical mass measurements, will be necessary before a prototype can be developed. This project is at least 3 years distant.

Although items E and F of the outline shown in the Introduction were discussed, it was felt that the scope and time available for this study precluded any intelligent presentation at this time.

Proposed design criteria may be modified as a result of R&D studies under way on semi-automated ring removal equipment.

Not all of the criteria and recommendations given in this report were unanimously supported by all members of the committee.