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THE ALLEGED 231-Z DISCHARGE OF PLUTONIUM
TO THE 216-Z-19 DITCH February 1977

R. E. Wheeler

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THE ALLEGED 231-Z DISCHARGE OF PLUTONIUM
TO THE 216-Z-19 DITCH February 1977

Prepared by
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Environmental and Occupational Safety Department

March 15, 1978

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The Alleged 231-Z Discharge of
Plutonium to the 216-Z-19 Ditch
February 1977

Scope

This report describes circumstances involved in the alleged 91.2 grams of plutonium released to the 216-Z-19 Ditch from the 231-Z facility. The following areas were reviewed:

1. 231-Z liquid waste data collected by Battelle-Northwest and Rockwell Hanford Operations (Rockwell).
2. The sampling methods used by Battelle and Rockwell.
3. Operating conditions in the 231-Z and 234-5Z Buildings at the time of the alleged release.

Introduction

Battelle-Northwest operates the 231-Z Building, Plutonium Metallurgy Laboratory, which continuously discharges cooling water to the 216-Z-19 Ditch. Research operations with plutonium was the primary work in the facility until January 1975 at which time phase-out was announced and implemented. By February 1977 all work with plutonium had ended and the plutonium contaminated equipment was being removed as part of the decontamination and restoration project. Weekly samples collected by Battelle since 1968 indicated that 231-Z liquid discharges to the Z-19 Ditch were well below the maximum permissible concentration for ^{239}Pu in water (Department of Energy MC 0524, Annex A, Table I). Samples collected by Rockwell Radiation Monitoring indicated the same. However, weekly samples collected by Rockwell Tank Farm Support indicated that the stream exceeded the plutonium concentration guideline in February 1977. These concentration numbers were multiplied by a monthly discharge volume which was established prior to phase-out and was three to five times the actual value. Consequently, Rockwell's first quarter 1977 discharge document¹ reported that the 231-Z facility released 91.2 grams of plutonium to the Z-19 Ditch in February 1977.

The 216-Z-19 Ditch receives low-level radioactive liquid waste from the Z Plant complex as well as cooling water from 231-Z. During the first quarter 1977, the Tank Farm Support collection point for 231-Z liquid waste samples and sampling instructions were not well defined. Some samples were probably taken from the Z Plant outfall to the Z-19 Ditch.

On January 31, 1977, Z Plant began experiencing problems in the 26-inch vacuum exhaust line which caused an initial release of $0.56 \mu\text{Ci/liter}$ gross alpha to the Z-19 Ditch. Subsequent releases occurred in February as the result of HEPA filter changes. The February 1977 Tank Farm Support samples from 231-Z waste showed an average gross alpha concentration of $0.25 \mu\text{Ci/liter}$ while Battelle samples showed less than $1.2 \times 10^{-5} \mu\text{Ci/liter}$. The conclusion was that the Tank Farm Support samples did not represent the 231-Z waste stream and it is highly improbable that the 91.2 grams of plutonium release actually occurred. Sufficient justification exists to consider the reported February 1977 release erroneous.

¹ J. E. Mirabella, Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During the First Quarter of 1977, RHO-CD-34 1Q, July, 1977.

Facts

1. The 216-Z-19 Ditch receives process cooling water, steam condensate, roof and sink drain water, vacuum pump seal and compressor cooling water from the Z-Plant complex and cooling water from the 231-Z Building. Figure 1 is a sketch illustrating the 216-Z-19 Ditch and feeder streams.
2. The Z-Plant effluents are monitored by a continuous sampler at the 2904-ZA sampling station. Additional sampling is provided by a Radiation Monitoring continuous sampler (Rockwell Environmental Monitoring Station No. 5) which is located in the Z-19 Ditch on the upstream side of the dams, a few feet downstream of the Z-Plant outfall. (See Fig. 1)
3. Battelle-Northwest collects and analyzes weekly grab samples of the 231-Z Building liquid waste. The analytical results were not being reported to Rockwell until after September 1977. Since 1968, the samples have been taken directly from the 231-Z waste stream at the concrete outfall to the Z-19 Ditch head end. The maximum gross alpha concentration observed on these samples was 3.6×10^{-4} $\mu\text{Ci/liter}$. The Department of Energy MC 0524, Annex A, Table I limit (maximum permissible concentration) for ^{239}Pu in water is 1×10^{-1} $\mu\text{Ci/liter}$. The maximum gross alpha concentration observed on the samples during January 1975 through September 1977 was 1.2×10^{-4} $\mu\text{Ci/liter}$.
4. During the period January 1972 through December 1974, the Rockwell Radiation Monitoring group collected weekly grab samples of the 231-Z waste stream for environmental surveillance. The sample point and techniques were the same as those used by BNW. The sample point is also identified by a sign above the 231-Z concrete outfall (Rockwell Environmental Monitoring Station No. 1). The maximum gross alpha concentration observed on any of these samples was less than 8×10^{-4} $\mu\text{Ci/liter}$.
5. In June 1975 Rockwell Tank Farm Support began taking 231-Z waste samples which were used as the basis for quarterly discharge reports. Figure 2 summarizes the gross alpha concentration on these samples. The samples were collected weekly, composited, and analyzed monthly. The results were reported to Rockwell management in monthly water composite summaries. Battelle was not notified of the results until the quarterly discharge reports were issued several months after analyses.
6. According to the Supervisor, during the first quarter 1977 the Tank Farm Support personnel who collected 231-Z samples for Rockwell were having a dispute as to where along the Z-19 Ditch to take the sample. An operator stated that she was originally trained to collect the sample from 234-5 Z outfall. A search for procedures revealed that there are no written instructions as to where and how to collect 231-Z liquid waste samples.

FIGURE I

This sketch shows the 216-Z-19 ditch and its sources of feed. Only the major Z-Plant streams are shown. (Not to scale)

FIGURE II
Monthly Concentration of ^{231}Z Waste Based on
Tank Farm Support Samples

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Facts continued

7. On March 25, 1976, the sample results from 2904-ZA indicated a release of plutonium, 7.90 $\mu\text{Ci/liter}$ gross alpha over five hours, to the Z-19 Ditch from Z-Plant. (Rockwell Occurrence report No. 76-43 was issued). The sample for the previous eight hours showed 1.85 $\mu\text{Ci/liter}$ gross alpha. After the release, samples from Environmental Monitoring Station No. 5 routinely showed gross alpha concentration between 0.01 and 0.1 $\mu\text{Ci/liter}$ through April 1976. A series of dams were added in the ditch downstream from the Z-Plant outfall to help retain the activity. The placement of these dams raised the liquid level and formed a lake in the ditch which backed up to the 231-Z concrete outfall at the head end. Tank Farm Support samples collected in March 1976 showed 0.35 $\mu\text{Ci/liter}$ gross alpha in the 231-Z stream. This data was not used as the basis for reporting the March 1976 discharges to the Z-19 Ditch. Instead, the analysis of 1.2×10^{-5} $\mu\text{Ci/liter}$ gross alpha was used which was obtained from Battelle. Tank Farm Process Engineering reviewed the Tank Farm Support sample data and determined that a sample collected on March 25 was from the Z Plant discharge to the ditch.
8. On January 31, 1977, the 2904-ZA sample showed a gross alpha concentration of 0.56 $\mu\text{Ci/liter}$. (Rockwell Occurrence report No. 77-21 was issued). The source of contamination was traced to the breakthrough of the HEPA filter unit on the 26-inch vacuum exhaust line. Subsequent releases to the ditch from Z Plant occurred during February 1977 as a result of the 26-inch vacuum exhaust HEPA filter changes. The sampler at the Environmental Monitoring Station No. 5 was not operating properly during the first few months in 1977 and it did not measure activity after the release.
9. Rockwell's discharge document issued in July 1977 reported 91.2 grams of plutonium discharged from the 231-Z facility to the 216-Z-19 Ditch in February 1977. This report was based on a estimated discharge volume of 6×10^6 gallons per month, and Tank Farm Support samples which showed an average concentration of 0.25 $\mu\text{Ci/liter}$ gross alpha.
10. At the end of each month the Rockwell water laboratory adds all liquid waste samples collected from a specific stream during the month together to make a composite sample which is analyzed for radio-nuclides. Radiation Monitoring was notified after 0.25 $\mu\text{Ci/liter}$ gross alpha was found in the 231-Z waste stream composite sample for February 1977. A survey was made along the Z-19 Ditch head end and there was no unusual contamination found. The matter was not pursued any further until the discharge report was issued.
11. The primary work in the 231-Z Building was plutonium research operation until January 1975. At that time, phase-out was announced and by February 1977 all work with plutonium had ended.

Upon being notified of the alleged February 1977 release, BNW performed a review of operating conditions in 231-Z during the first quarter of 1977, including equipment use, Nuclear Materials Accountability records and analytical data on liquid effluent samples.

Facts continued

Upon being notified of the alleged February 1977 release, BNW performed a review of operating conditions in 231-Z during the first quarter of 1977, including equipment use, Nuclear Materials Accountability records and analytical data on liquid effluent samples.

Approximately 40 percent of the laboratory was in construction status.

There was no work in the laboratory involving plutonium.

The glove boxes with plutonium contamination were being prepared for removal from the facility as part of the 231-Z decontamination and restoration project. The vacuum pumps used for glove box exhaust were shut down.

Analytical results on BNW samples for February 1977 231-Z liquid waste showed less than 1.2×10^{-5} $\mu\text{Ci/liter}$ gross alpha.

Based on the review, Battelle issued an Occurrence Report which concluded that the release of 91.2 grams of plutonium was extremely improbable.

12. The 231-Z Facility had no means of measuring the discharge volume or taking automatic samples of the liquid effluents discharged to the Z-19 Ditch. The reported discharge volume of 6×10^6 gallons (150 gpm), was based on the 200 Area powerhouse estimate of water billed to the 231-Z Building. This estimate was established before the 1975 plutonium research phase-out began. Because of phase-out, Battelle estimated the discharge flow rate to be 30 to 50 gpm.
13. The following guidelines for liquid effluent monitoring are prescribed in Department of Energy MC 0513:

Monitoring should be conducted in a manner that provides accurate measurements of the quantity and concentration of radioactivity in liquid effluents as a basis for determining compliance with applicable discharge control limits, evaluating the adequacy and effectiveness of containment, waste treatment, control, efforts toward achieving releases as low as practical, and compiling an annual inventory of the radioactivity released to the environment.

Measurements of volume, rate of discharge, and content should be made insofar as is practical, at the point which most closely represents what is being released.

Facts continued

Continuous sampling may be warranted where there is wide variation in the concentration or mixture of potential pollutants in the effluent stream. However, periodic sampling may suffice when the concentrations and mixtures are reasonably constant and there is little likelihood of unusual variation. Similarly, proportional sampling may be necessary when effluent flow rates fluctuate, whereas a representative grab sample may suffice for batch discharges.

Analysis

1. Liquid samples collected by Battelle since 1968 indicate that 231-Z discharges to the Z-19 Ditch were well below the maximum permissible concentration for ^{239}Pu in water (Department of Energy MC 0524, Annex A, Table I). Samples collected by Rockwell Radiation Monitoring indicated the same. According to Rockwell Tank Farm Support samples, the 231-Z waste stream exceeded the maximum permissible concentration for ^{239}Pu in water in March 1976 and February 1977. On several occasions the results on Tank Farm Support samples show twice the maximum concentrations observed on any Battelle sample (See Fig. 2). Consequently, Battelle and Tank Farm Support samples show wide disagreement on the plutonium concentration in 231-Z liquid discharges.
2. The Tank Farm Support group was having problems as to where to take 231-Z waste samples in the ditch. There were no written sampling instructions. At least one operator was trained to collect Z-Plant effluents for 231-Z waste samples. On two occasions between June 1975 and August 1977, Tank Farm Support samples showed that 231-Z was discharging plutonium at the same time that Z-Plant was proven to be discharging waste that exceeded release limits. Therefore, 231-Z waste samples collected by Tank Farm Support may be more representative of 234-5Z Plant than 231-Z.
3. The results on 231-Z waste samples collected by Tank Farm Support were used as the basis for quarterly discharge reports. These results were reported within Rockwell monthly. However, Battelle did not receive any notification on these results until the quarterly discharge reports were issued. Battelle received notification of the alleged February 1977 discharge at least five months after the release was to have occurred. Therefore, Battelle did not receive the notification to react to a possible out of standard condition.
4. The placement of dams in the 216-Z-19 Ditch after the March 1976 occurrence at Z-Plant caused the water to back up and rise above the 231-Z discharge outfall. Since this occurred, any sample taken from the head end of the ditch is actually a sample of the lake formed by the dams.
5. A review of facility operations showed that there were no activities in the 231-Z Building that could have caused the February 1977 alleged release. Grab samples of the 231-Z waste stream collected by Battelle between June 1975 and August 1977 indicate that releases to the Z-19 Ditch were well below Department of Energy MC 0524, Annex A, Table II release guidelines. This is an indication that the concentrations and mixtures in the 231-Z waste stream are reasonably constant and there is little likelihood of unusual variation. The Battelle samples were collected from the 231-Z discharge outfall to the Z-19 Ditch while the collection point was not defined for the samples that discharge reports were based on. Therefore, the Battelle grab samples of the 231-Z waste should provide the best data to base discharge reports on through August 1977. However, a proportional sampler and flowmeter would be desirable to monitor the 231-Z liquid waste since it is a continuous discharging stream.

Conclusion

1. The samples that the discharge report was based on were taken under poorly controlled conditions and from locations in the Z-19 Ditch which did not reflect the outfall from the 231-Z Building. The 234-5Z Building was experiencing discharges which were probably causing high results on 231-Z waste samples. Therefore, it is highly improbable that the 91.2 grams of plutonium released from the 231-Z Building to the 216-Z-19 Ditch actually occurred. Sufficient justification exists to consider the reported February 1977 release erroneous.
2. Because of the placement of dams in the Z-19 Ditch in March 1976 which caused the 231-Z waste to discharge below water level, adequate samples may be difficult to obtain from the outfall. However, the Battelle samples provide the best data to base discharge reports on since they were collected from the 231-Z discharge outfall while the collection point for Rockwell samples was not defined.
3. Rockwell collected 231-Z liquid waste samples from June 1975 through August 1977 as basis for discharge reports, but did not provide Battelle with immediate notification when the concentration of nuclide exceeded release guidelines. Battelle received notification about five months after the 91.2 grams of plutonium release allegedly occurred and could not respond to a possible out of standard condition. On the other hand, Battelle did not provide Rockwell with its data on discharges to the 216-Z-19 Ditch.

Recommendations

1. Battelle-Northwest should install a proportional sampler and flowmeter in the 231-Z liquid waste stream in such a location that the samples will not be influenced by Z-Plant liquid discharges or the dams in the ditches. Battelle-Northwest should provide Rockwell with monthly reports on volume of liquid and concentration of radionuclide discharges from the 231-Z Building. Discharges that exceed Department of Energy MC 0524, Annex A, Table II limits for water should be reported to Rockwell immediately upon discovery.
2. Rockwell should discontinue collecting 231-Z liquid waste samples and the discharge reports should be based on data provided by Battelle-Northwest.
3. Effective January 1, 1977, Rockwell Radioactive Liquid Waste discharge reports should be changed to reflect Battelle-Northwest data on the 231-Z waste stream.
4. Rockwell should initiate measures to insure that procedures are established to give the associated facility landlords immediate notification when samples from liquid effluents streams or disposal sites exceed established guidelines.

Recommendation continued

5. Rockwell should review liquid effluent sampling procedures for all facilities to insure that the methods and collection points are providing representative samples of the waste streams.
6. Rockwell should remove the dams from the ditch to minimize effects on sampling.

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