Waksalaski

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF ENGINEERING
DEPARTMENT OF NUCLEAR ENGINEERING

BERKELEY, CALIFORNIA 94720

RECEIVED NRC
1985 OCT 25 A 10:00
REGION V

October 23, 1985

U. S. Nuclear Regulatory Commission
Region V
1450 Maria Lane, Suite 210
Walnut Creek, California 94596-5368

Attention: Regional Administrator

Reference: Berkeley Research Reactor (BRR)
License No. R-101, Docket No. 50-224

Subject: Written report of items previously reported by telephone by Tek Lim, Reactor Supervisor, on October 17-21, 1985

Dear Sir:

Section 6.7.b(3) of the Berkeley Research Reactor Technical specifications requires written follow-up reports on items previously reported to your organization by telephone, under section 6.7.a(3) of the subject Technical Specifications. This report fulfills our reporting obligation.

1. The reactor was tested on September 16, 1985, after a long maintenance shutdown period of approximately 20 days. During the final half hour of a two-and-a-half-hour test at one MW, a sudden rise occurred on the Constant Air Monitor (CAM). At the time the reactor was scrammed, the reading was approximately 500 counts per minute (cpm) above background. Normal reading for similar such operation is approximately 50 cpm above background on the CAM. After the reactor was scrammed, it was noted that the CAM reading continued to rise. At approximately 45 minutes after the reactor was shutdown, the high radiation alarm of the CAM was activated (high set point was set at 5000 cpm).

To prevent release of airborne radioactivity outside the reactor room, the reactor room ventilation system was switched to the emergency mode. The reactor room was then evacuated. It was noted that all other monitors (stackgas, area radiation monitor) indicated normal readings. The reactor room ventilation was left in emergency mode until the next day.

8511040070 851023
PDR ADOCK 05000224
S PDR

cont. . . .

IE22
1/0

On September 17, the reactor room was reopened for normal business, after it was found that all radiation monitors, including the CAM readings, had returned to background level.

Gamma ray analysis of the room air, pool water and the air filter revealed that the primary activity in the pool water was Na-24, Ar-41 in the air. The following is a list of activation products found in the pool water.

<u>4 hours after scram</u>:

Na-24	5.4×10^{-4} μCi/ml (microcuries per milliliter)
Ar-41	2.7×10^{-4} μCi/ml
Mn-56	1.4×10^{-5} μCi/ml

The following is a list of activation products found in the air and air filter.

<u>2 hours after scram</u>:
Ar-41 in the air. (normal)
Natural thorium/uranium decay products in air filter. (normal)
No other isotopes were found.

The abnormally high pool activities of Na-24 was suspected to have come from activation of accumulated impurities found in the pool water. These impurities were believed to have accumulated to above normal levels during the three week shutdown of the reactor while repair work was done on the reactor fission chamber. No circulation and filtering of the pool water occurred during that time.

The staff started cleaning the pool water on September 17 by circulating the pool water through the demineralizer 24 hours a day and vacuum cleaning the pool. To accelerate the process, the ion exchange resin of the reactor pool water filter system was replaced on September 19 and 20.

On September 18, the Reactor Supervisor made a courtesy call to M. Cillis, the NRC inspector assigned to the BRR. The Reactor Supervisor explained the chronological sequence of events, followed by a discussion. Both agreed that the incident did not require reporting to the NRC.

On September 20, the incident was reported to the Reactor Administrator and to the Reactor Hazard Committee at its regular meeting that morning.

2. During a follow-up test on September 24, 1985, the reactor was operated for about 2.5 hours at 1 MW. During the test, the air

particulate monitor read about 500 cpm above background at the end of the operation, and about 1200 cpm maximum one hour later. The first reading was approximately the same as that observed on September 16, 1985. The second reading was much lower. This time it did not trip the high alarm set point. The water conductivity was reduced to approximately 1 μ mhos per cm after replacing the resin, down from 3 - 5 μ mhos per cm prior to the incident. The stackgas and water monitor read normal. Cleaning the pool helped reduce the airborne activity considerably, however it did not eliminate the problem completely. Isotope analysis revealed that no fission products could be detected in the reactor room air, on the constant air monitor filter paper, or in the pool water. It was thought at that time that the pool water was not sufficiently filtered to eliminate the airborne activities completely. The filtering process was continued for approximately two more weeks.

3. During a test on October 11, 1985 fission gases were found in the reactor room air after a two hour operation at 1 MW. Stackgas and water monitor readings were normal. The air particulate monitor readings were almost the same as the readings obtained during the test on September 24. Conservative estimates, through a combination of multichannel analysis and stackgas monitor calibration, indicated the following maximum concentrations of detectable fission gas in the reactor room (with the ventilation in emergency mode) at 45 minutes after scram:

Kr-85m	1.1×10^{-10} μCi/ml
Kr-87	6.5×10^{-9} μCi/ml
Kr-88	5.8×10^{-9} μCi/ml

These concentrations were lower than the allowable maximum concentrations in unrestricted areas averaged over a year as stated in 10 CFR 20, Appendix B. The reactor room emergency ventilation system was activated immediately after scram and left on until Monday, October 14, 1985, at 08:00 AM. Therefore, the majority of these fission gases were confined in the reactor room until they disappeared by radioactive decay.

The NRC was informed on October 14 immediately after the results of the above analysis indicated the presence of fission gases. The incident was reported to Mr. Conrad Sherman, representing Inspector Mike Cillis, who was out of town. The Reactor Administrator, the Chairman of the Reactor Hazards Committee and the Office of Environmental Health and Safety were also informed.

At this time, it was suspected that the fission gases might have leaked from the fission chamber, which had been rebuilt just prior to the first testing. In addition, all attempts to detect fission products in the reactor water and demineralized resin were negative. It was decided that another test would be conducted on October 16, as soon as a replacement for the BRR fission chamber became available.

A memo was issued by the Reactor Supervisor to limit routine operations to 1 MWh during a period not less than 8 hours. This was to remain in effect until the problem was resolved. This plan was also transmitted to Mr. Sherman of the NRC who subsequently gave his approval.

4. On October 16, the BRR fission chamber was unloaded from the core and replaced with a temporary chamber. The reactor was taken to 1 MW for two hours, starting at 1:30 PM. After one and a half hours of operation, the air particulate monitor reading rose with a similar pattern as that obtained during the last two tests, to about 200 cpm and to 300 cpm above background at the end of the two hours period. Other monitors read normal. The ventilation was again put in the emergency mode immediately after the reactor was scrammed to keep any fission gases from being released outside the reactor room.

Results obtained on October 17, from direct analysis of reactor room air, using the same method as on October 14 (60 minutes after scram) were as follows:

Kr-85m	2.5×10^{-10} μ Ci/ml
Kr-87	2.4×10^{-9} μ Ci/ml
Kr-88	3.4×10^{-9} μ Ci/ml

Therefore, we concluded that the original fission chamber had not caused the release of detectable fission gases.

The NRC Region V Office was immediately informed that day. A plan for further testing was discussed with, and approved by, Mr. H. North and M. Cillis. Also, the situation and plans were discussed with the Reactor Administrator and Prof. V. Schrock, who represented the Reactor Hazards Committee, in the absence of Prof. Buxbaum, at the request of Vice Chancellor Tien.

All routine operations were immediately suspended starting as of Thursday afternoon, October 17, 1985.

5. On October 17, after it was known that the fission gases released during testing of the reactor on October 14 and 16 were not coming from a leaking fission chamber, a plan was made to locate the leaking fuel element. The procedure adopted is described below:

- A bundle of up to five individual fuel elements will be unloaded from the core during each isolation operation. The maximum worth of a bundle of fuel elements is not to exceed $1.20.

- During each isolation operation, the reactor will be operated at 1 MW for 2 hours.

- The currently available excess reactivity is $4.90. The reactor power associated reactivity at 1 MW operation is $3.50. Therefore, the excess reactivity remaining at 1 MW operation is $1.40. Assuming that up to 5 fuel elements, with a maximum worth of $1.20, are unloaded from the core, a core excess of $0.20 will still remain available during the 2 hour isolation operation. Since the effect of Xe-135 will be less than $0.20 during such an operation, sufficient reactivity is available.

- Immediately after the reactor is scrammed, the ventilation system will be switched to the emergency mode. The Constant Air Monitor (CAM) filter paper will be immediately analyzed, followed by analysis of the reactor room air.

- During the above operation, all radiation monitors will be carefully monitored, especially the CAM.

- If, fission gases are still detected, the previously unloaded fuel elements will be reloaded and another group (1 to 5) of fuel elements will be unloaded for the next test.

- This process will be repeated until the leaking fuel element is located.

6. Following approval of the above procedure by the Reactor Hazards Committee (represented by Prof. V. Schrock), the Nuclear Regulatory Commission, Region V Office (represented by Mr. M. Cillis), and the Reactor Administrator, three instrumented fuel elements, #4310, #4311 and #5666, were unloaded (removed) on October 18 from core positions G-2, G-3 and G-4, respectively. These elements contain defective thermocouples and were used only as fuel elements. They were loaded to

the core in 1978 and have since functioned with no problem.

The reactor was taken to 1 MW the same morning. After two hours of operation, all radiation monitors read normal, no rise in reading was noted on the CAM. It was then decided to continue operation for another hour.

After three hours of continuous operation at 1 MW, the reactor was scrammed. No rise in reading was noted on the CAM. Other monitors indicated normal readings. Gamma spectrum analysis of the CAM filter paper and the reactor room air indicated no fission-gas activity.

The leaking fuel had thus been isolated to one or more of the three unloaded instrumented fuel elements.

After discussion with the Reactor Administrator, it was agreed not to reuse any of these fuel elements. We felt that the design of the instrumented elements coupled with their use at the BRR had contributed to cladding failure. Having identified and removed the source of the leak, no further testing was necessary.

7. To maintain sufficient excess reactivity for normal operations, three new standard fuel elements, #7922, #7923 and #7924, were loaded on October 21 to core positions G-2, G-3 and G-4 respectively.

To confirm that no leaking fuel element was present the reactor was then operated for three hours at 1 MW. No abnormal readings were noted on any radiation monitors. Gamma spectrum analysis of the CAM filter paper indicated no fission-gas activity.

The situation was reported immediately to the Reactor Administrator, Chairman of the Reactor Hazards Committee, and the Nuclear Regulatory Commission Region V Office (represented by M. Cillis). Permission to resume normal operation, starting October 22, 1985, was granted by the NRC Region V Office on October 21, 1985 and approval was obtained from the Reactor Administrator and Chairman of the Reactor Hazards Committee.

The three removed instrumented fuel elements are now stored in the reactor pool. As soon as radiation levels permit, they will be stored in the facility storage well. A readout of the CAM is now installed at the reactor console area to improve monitoring of the CAM system.

Should there be questions regarding any of the above infomation,

please let us know.

Sincerely yours,

T. H. Pigford
Reactor Administrator

THP:sf