United States Department of the Interior

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U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555

Dear Sirs:

SUBJECT: REPORT OF FUEL ELEMENT CLADDING LEAK AT USGS TRIGA

Attached is a written report with details concerning a minor fuel element cladding leak that we experienced on January 4, 1994. The presence of fission product activity in the reactor water and reactor room air was positively identified and this was reported to both NRC headquarters and Region IV offices by telephone on January 5. The USGS research reactor returned to routine operation on January 5, 1994.

If you have further questions regarding this report, please contact Tim DeBey at (303) 236-4726.

Sincerely,

Dr. Carl E. Hedge
Reactor Administrator

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FUEL ELEMENT CLADDING LEAK - USGS - January 1994

A fuel element cladding leak was detected at the USGS TRIGA reactor facility by observing increased readings on the facility's continuous air monitor (CAM). The abnormal indication was detected on January 4 after 6.5 hours of operation at full power (1 MW). The CAM increase started approximately 20 minutes after the reactor shutdown. Gamma analysis of the CAM filters determined that Rubidium-88 and Cesium-138 (fission product daughters) were present, at a concentration of approximately 4×10^{-9} µCi/ml. The indications were similar to those during a fuel element clad failure that occurred in June of 1992 at the facility where all CAM increases occurred after reactor shutdowns, approximately 15 to 45 minutes following the rod insertions.

No personnel were in the reactor room when the fission product activity was initially detected and access to the reactor room was then further restricted. The ventilation system was manually placed in the emergency mode to provide filtration through a HEPA filter. Close monitoring of the CAM and analysis of the CAM filters showed that the total release occurred over about 100 minutes. A reactor water sample was also collected for later gamma analysis.

The released fission products were identified as Krypton-85m, Krypton-88, Krypton-87, Rubidium-88, Xenon-133, Xenon-135, Xenon-138 and Cesium-138. The particulate isotopes of Rubidium and Cesium were detected on the CAM filters while all identified fission product isotopes were detected in the water sample. All samples and filters were analyzed on a high purity germanium detector. The longest lived isotope was Xenon-133, with a half-life of 5.24 days. The maximum personnel dose equivalent from fission products was evaluated to be much less than 0.1 mrem for the event.

After discussions among reactor personnel, the fission product source was deemed to be so similar to the incident of June 1992 that the fuel history records were examined for similar fuel elements. This showed that the core contained two instrumented fuel elements that were of the same vintage and history as the instrumented fuel element that leaked in 1992 (S/N 5667). On the morning of January 5, those two elements were removed from the core for inspection. Upon movement of element S/N 5668, bubbles were noted coming from a corroded spot on the side of the element. This was a positive indication of a breech in the cladding and the element was permanently removed from service and placed in storage. The third similar element, S/N 5669, was also removed from service even though a visual inspection revealed no indications of cladding corrosion. Subsequent reactor operations have verified that the fission product source has been eliminated.

The following table gives data for the specific isotopes that were detected, with all concentrations in µCi/ml.

ISOTOPE DATA FOR FISSION PRODUCTS DETECTED

Isotope	Half-life	10CFR20 DAC, Table I	10CFR20 Effluent, Table II
Kr-85m	4.48 hr	2E-5	1E-7
Kr-87	1.27 hr	5E-6	2E-8
Kr-88	2.8 hr	2E-6	9E-9
Rb-88	17.7 min	3E-5	9E-8
Xe-133	5.24 days	1E-4	5E-7
Xe-135	9.1 hr	1E-5	7E-8
Xe-138	17.5 min	4E-6	2E-8
Cs-138	32.2 min	2E-5	8E-8

The detected fission products gave calculated maximum concentrations in the reactor room air as shown below. It is estimated that the release from the reactor facility occurred over a 100 minute period. The effluent concentration is calculated using a very conservative dilution factor of 141 for air exhausted from the reactor facility stack to the point outside the building, nearest to the reactor exhaust. The reactor room was occupied for approximately two minutes during this event, giving approximately 0.001 DAC-hr equivalent exposure to that individual. This results in much less than 1 mrem total effective dose. The point outside the building that is nearest to the reactor exhaust was unoccupied during the event. All activity levels and exposures were significantly less than the limits of 10CFR20.

Isotope	Level	DAC	% of DAC	Effluent level	Effluent limit	% of limit
Kr-85m	1.3E-8	2E-5	0.065	9.2E-11	1E-7	0.09
Kr-87	6.4E-8	5E-6	1.28	4.5E-10	2E-8	2.27
Kr-88	3.1E-8	2E-6	1.55	2.2E-10	9E-9	2.44
Rb-88	3.6E-9	3E-5	0.012	2.6E-11	9E-8	0.03
Xe-133	5.5E-8	1E-4	0.055	3.9E-10	5E-7	0.08
Xe-135	4.0E-9	1E-5	0.04	2.8E-11	7E-8	0.04
Xe-138	4.6E-8	4E-6	1.15	3.3E-10	2E-8	1.63
Cs-138	5.9E-10	2E-5	0.003	4.2E-12	8E-8	0.01
SUMS			4.155%			6.59%

The total activity released is estimated to be 259 microcuries, with Kr-87, Xe-133 and Xe-138 gases accounting for about 75% of the total activity. This event was below the action levels for all emergency classes in the facility emergency plan; therefore, the facility emergency plan was not initiated. The failed fuel element was found so quickly that routine facility operations were only affected for approximately 3 hours.