UNIVERSITY OF VIRGINIA
DEPARTMENT OF NUCLEAR ENGINEERING AND ENGINEERING PHYSICS
NUCLEAR REACTOR FACILITY
SCHOOL OF ENGINEERING AND APPLIED SCIENCE
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November 1, 1984

Mr. James P. O'Reilly
Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street NW
Atlanta, Georgia 30323

Subject: Licensee Event Report

Gentlemen:

In accordance with the provisions stated in section 20.405 a(v) of 10 CFR 20 (Reports of overexposures and excessive levels and concentrations), a written report is hereby presented to document an incident which occurred at the University of Virginia's Nuclear Reactor Facility, during a short period of time, involving levels of radiation in an unrestricted area slightly in excess of ten times the applicable 10 CFR 20 limit.

Description of Incident - Levels and Causes

On October 2, 1984, during a routine unannounced inspection conducted by NRC Region II Inspector Mr. Roy Weddington, of the University of Virginia Reactor Facility in the areas of health physics, effluent control and radiation safety, a high radiation "hot spot" was discovered at ground level along the outside wall of the UVAR reactor room, between the escape hatch and the gate to the roof leading to the cooling tower (Please refer to the attached enclosures). The maximum radiation level at ground level was measured at just below 40 mR/hr. The established radiation field was such that 5 mR/hr levels were reached at distances of about 30" in a circular radius about the hot spot and out to about 40" away from the wall.

The "hot spot" was produced by an experiment which had been placed in one of a series of 4" I.D. steel pipes, sunk into the reactor room floor next to the reactor room's outer wall at the time of construction of the Facility. The intended purpose of these shielding pipes was to accommodate and shield the activated reactor control rods, during repairs to the control rod drives or reactor core In actuality, these pipes had been rarely, if ever, used before this instance, for this intended purpose or for the shielding of experiments.

The experiment (radiation source), which had last been irradiated in the UVAR core on August 12, '84 as part of the Facility's Pressure Vessel Steel Irradiation Program, was taken out of the reactor pool on September 12, '84 and placed for decay in one of the "pipe shields" and covered with lead bricks. A radiation survey performed externally to the reactor room by the Facility's HP technician that same day, and once

weekly thereafter, unfortunately failed to detect the described radiation levels, in part because the routine survey, utilizing a Keithley 36100 digital read-out survey meter, was done at waist level. At this height the radiation field was $\leq$ 5 mR/hr and thus the instruments' slow response time combined with the sweeping technique employed were such that the radiation field was not detected.

The radiation field in question was inadvertently created, in part because of a reactor room building construction design deficiency. The grade level on the building's external side was 10" below the reactor room floor level, compromising the effective shielding to the outside of the Reactor Room. For lack of windows, this situation of reduced shielding to the outside with adequate shielding on the inside was never realized.

The NRC Inspector from Region II stated at his exit meeting with the Reactor Facility Staff that as a result of this incident we would be cited for a violation of 10 CFR 20 part 20.203.B concerning the Posting of a Radiation Area. Subsequently, during an Enforcement Conference held on October 22, 1984 upper-level management representatives at the University of Virginia were informed that the citation would be for a violation of 10 CFR part 20.201 (b) concerning Precautionary Procedures (Surveys) leading to a violation of 10 CFR part 20.105 concerning Permissible Levels of Radiation in Unrestricted Areas. This license event report is being filed based on this latest NRC verbal disclosure. At this time the U.Va. N.R. Facility has not yet been officially notified <u>in writing</u> of violations found during the last inspection.

<u>Radiation Levels Produced</u>

Following the discovery of the "hot spot" the Facility staff immediately removed the radiation source and relocated it to a shielded cask. On October 12, 1984 the source was replaced for a short time in the original shield pipe, under direct supervision of the HP staff, so that measurements could be made of the radiation levels produced outside of the building. These results of these measurements have been described in the preceding section. On October 16, 1984 a spectral analysis of the isotopes present in the source was made. Back-calculations revealed that the estimated field strength at the time the source was initially placed in the "shielded" pipe was 15% higher than at the time of discovery during the NRC Inspection. Since the experiment had been stored underwater in the reactor pool during one month, very short lived isotopes had decayed away by the time that the experiment was set into the pipe.

Applicable limit for radiation field in an unrestricted area:

100 mR/7 days $\div$ 168 hrs/wk = 0.595 mR/hr

Criteria for reporting the event:

10 x Applicable Limit = 5.95 mR/hr (in an unstricted area)

Actual and Estimated Radiation Levels:

Field strength on Oct. 2, 1984 as detected by Roy Weddington, at 36" height and 18" from bldg.	= 5.6 mR/hr
Estimated field strength for Sept. 12, 1984, when field was initially created	= 1.15 x 5.6 = 6.44 mR/hr (1.08 reporting limit)

Extent of Exposure to Individuals

The radiation field that had inadvertently been created in an unrestricted area was situated close (about 10 ft) to a posted transient radiation area by the cooling tower and located in a very low traffic area. It is probable that no personnel or members of the public were exposed during the 3 weeks that this condition existed. It should be noted that the programmed HP surveys which were regularly performed every week did not detect excessive radiation levels at waist level. To have been significantly exposed (whole body dose), an individual would have had to crouch against the wall at the precise spot for an improbable long time period. Any actual dose to passersby is likely to have been limited to the lower body extremeties.

Corrective Steps Taken

Immediate return to compliance with regulations was achieved upon discovery of the event, by appropriate relocation of the radiation source. A thorough investigation of the incident followed, with a recreation of the original situation, study of irradiation records, back-calculations, building construction parameter reviews and source spectral analysis.

The "shielded" storage pipes have long since been filled and sealed to prevent further use. The incident was reviewed during the following weekly Staff Meeting and was well discussed and analyzed. The incident was further reviewed during an Enforcement Conference (October 22, 1984) and a U.Va. Reactor Safety Committee Meeting (October 26, 1984).

The Facility's radiation survey program has already been revised to include more extensive exposure measurements, including ones at ground level. Upgrading and diversification of survey equipment is being studied, and consideration is being given to additional use of audible rate indicating instruments.

Conclusions

The incident which has been described here in all likelihood did not result in the exposure of any members of the public or Facility personnel.

We feel that our responses to correct this situation have been comprehensive in scope, adequate, timely and that compliance with regulations has been strengthened.

Sincerely,

Robert U. Mulder, Director
U.Va. Nuclear Reactor Facility

Brian G. Copcutt, U.Va.
Radiation Safety Officer

cc: USNRC Document Desk

Enclosures: Radionuclides Present in Rad. Source
Radiation Area Diagram & Photograph
UVAR Reactor Room Diagram

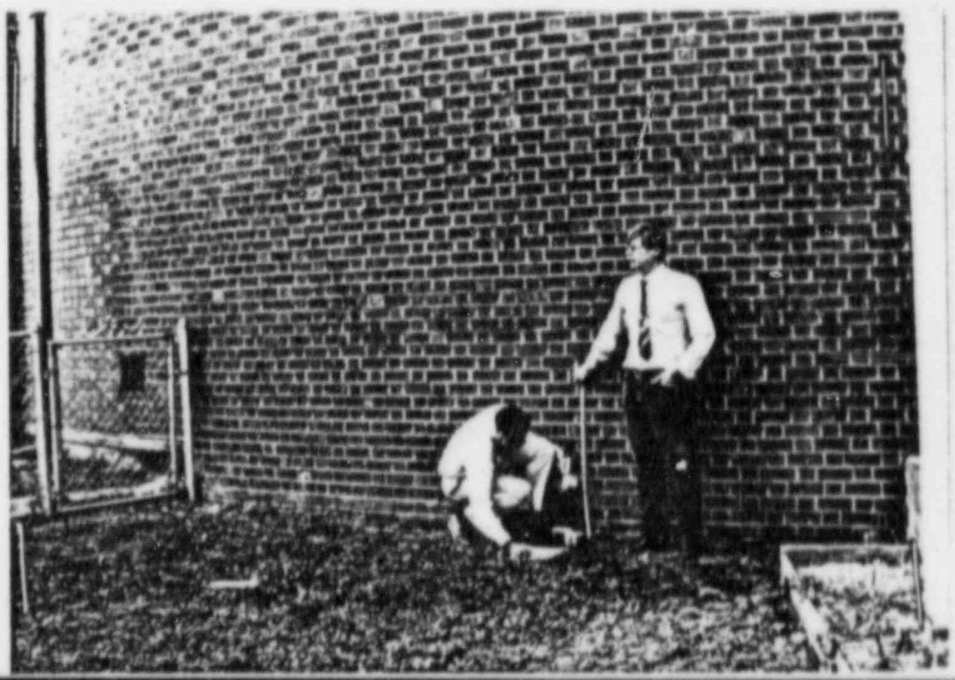
Sworn to and subscribed before me this 1st.
day of November 1984
Witness my hand and notarial seal.
Dolores E. Vass Notary Public
My Commission Expires October 14, 1985

Radionuclides Present in Sample as Determined by Spectral Analysis

Nuclide	% Dose Rate on 10/16/84	Halflife
Co-60	46	5.3 years
Mn-54	22	315 days
Co-58	14	71 days
Fe-59	9	44 days
Cr-51	7	28 days
Zn-65	2	244 days

Total Dose Rate Normalized to 10/2/84

Sample Placed in well	Radiation Area Discovered	Elemental Analysis Performed
9/12/84	10/2/84	10/16/84
1.15	1.00	0.93



RADIATION AREA DIAGRAM

SCALE 1:10

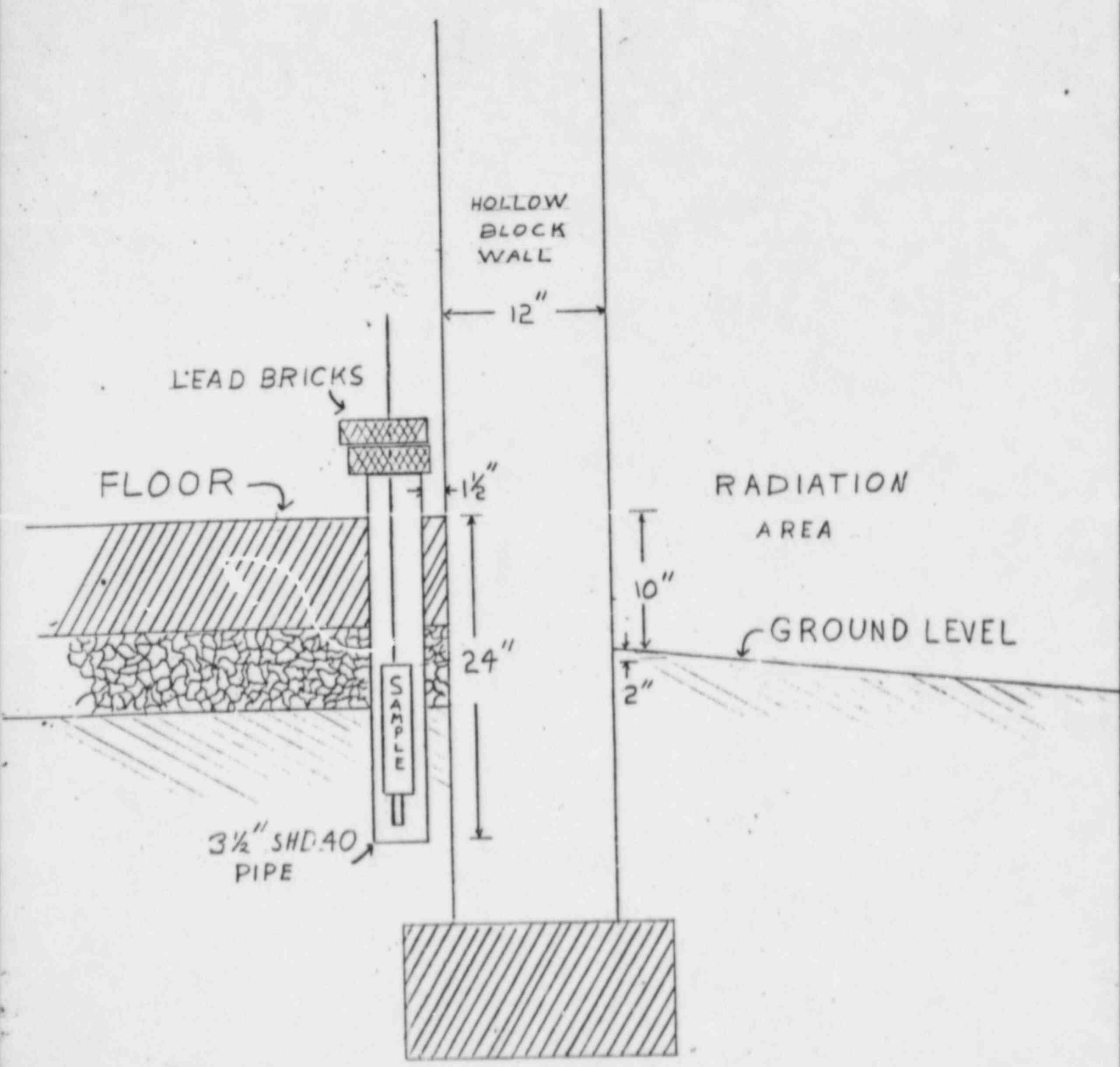
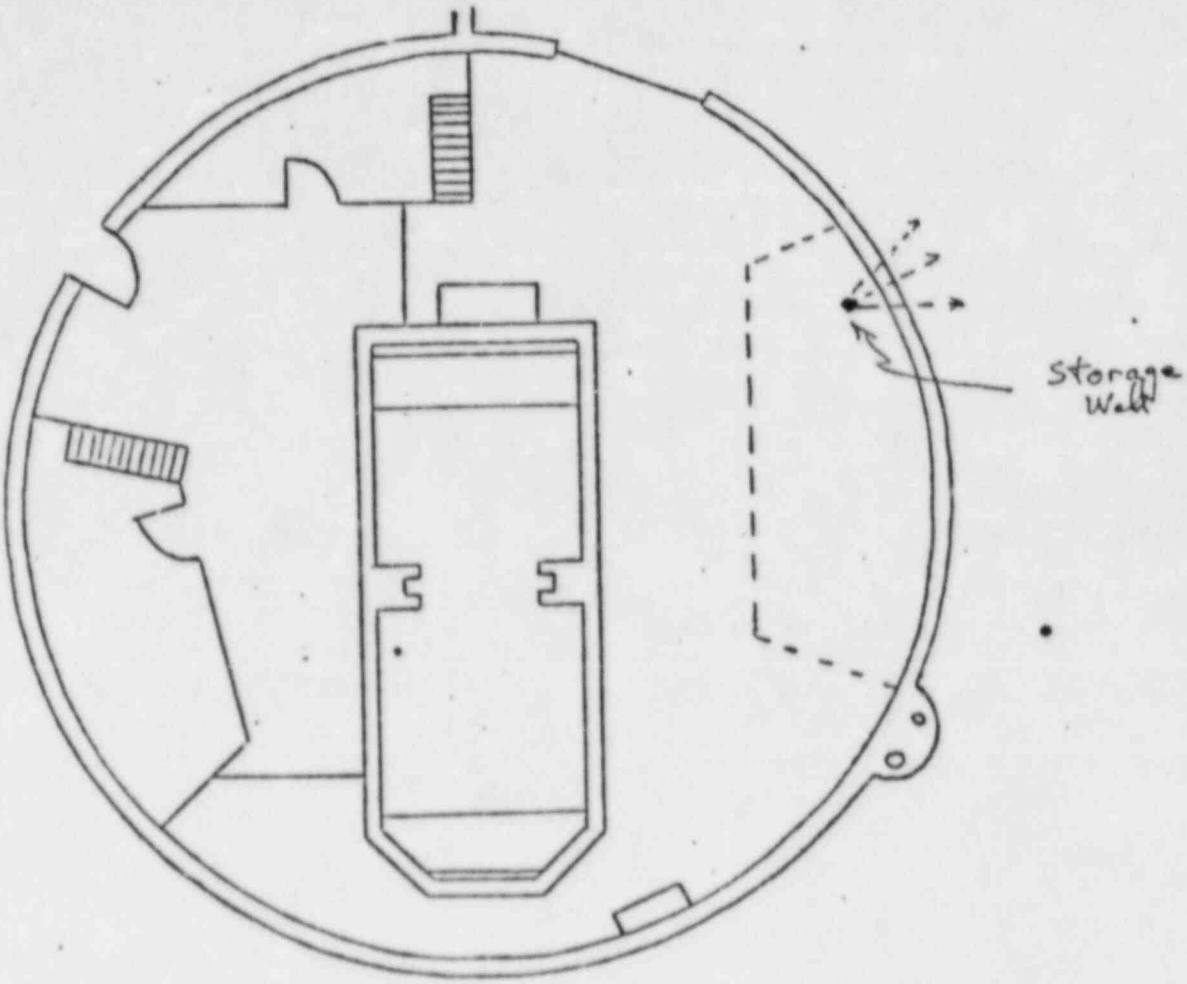
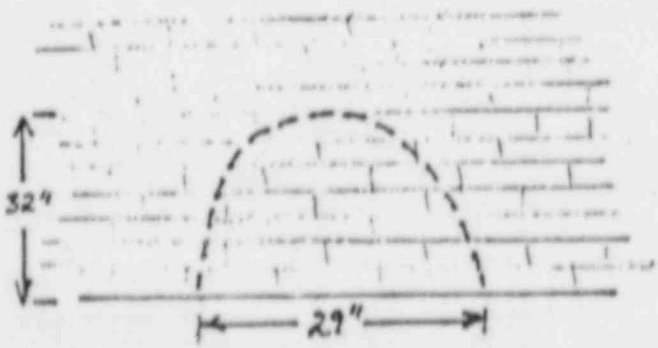


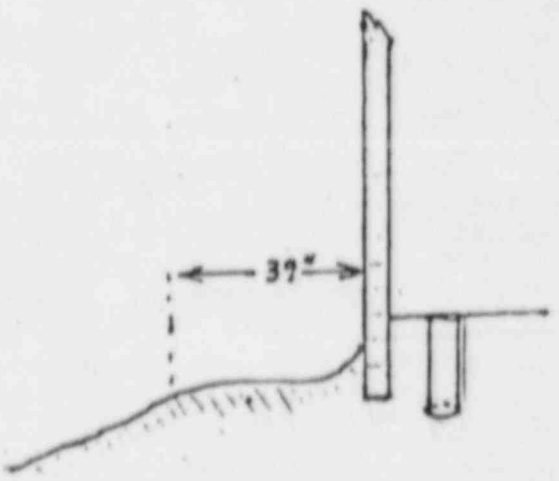
FIGURE 1

UVAR Room





Reactor Room Exterior Wall



Side View thru Wall