DORF EXPOSURE ROOM SURVEY REPORT

1. Background

1.1 During the period of 1961 through 1977, an Army Research Laboratory (ARL) predecessor organization, Harry Diamond Laboratories, owned and operated a TRIGA nuclear research reactor in a dedicated facility known as the Diamond Ordnance Radiation Facility (DORF). During the period of 1977 through 1979, the DORF was decommissioned, and released for unrestricted use. The DORF building has since been used as a radioactive waste storage area by the Walter Reed Army Medical Center (WRAMC). The building is now owned and operated by the Walter Reed Army Medical Center.

1.2 During 1996, the Army Reactor Office (ARO) at the U.S. Army Nuclear and Chemical Agency began a review of documents regarding all Army reactors, past and present. Of concern was whether such reactors including DORF were decommissioned in a way that complies with today's decommissioning standards. ARO's review of DORF final survey documentation indicated that although the gamma radiation levels complied with the decommissioning criteria of 1980, they might not comply with today's standard. The request for survey at Encl 1 was therefore sent to ARL.

1.3 ARL therefore planned and conducted the subject survey. To minimize the cost to the Army, all survey planning, area gridding, and measurements were conducted by Mr. Michael Borisky, the ALR Health Physicist. The ARL Radiation Control Committee was also used as a planning resource. A review of Rockwell's DORF Decommissioning Program Final Report (Encl 2) and associated surveys was first conducted to determine what types of surveys were conducted in the past, and what type was needed now. The results of the review, attached as Encl 3, indicated that past survey efforts are sufficient to demonstrate compliance with all of today's requirements except the criteria requiring that the gamma dose rate at one meter from surfaces not exceed background by more than 5 urem/hr. Since it was possible that the gamma survey would demonstrate compliance with the gamma levels, the survey was approached and conducted so that it might eventually serve as a final survey.

1.4 Although this survey encompasses only a small portion of the decommissioning and survey effort, an attempt will be made to follow the final report format recommended by the Nuclear Regulatory Commission in NUREG 5849. In this way, it is hoped that this report will be more complete and informative. If the reader seeks a greater level of detail on past information, it is requested the reader study the referenced and enclosed past documents and reports.

2. Site Description

2.1 Review of the decommissioning report and associated survey indicates that the only area of concern is the exposure room. The exposure room is a concrete structure

taken for isotopic analysis. There is no indication that samples of reinforcement bar were taken for isotopic analysis. Also as part of the decommissioning effort, a final survey of building surfaces, water, soil, and vegetation was conducted.

3.3 In 1980, the U.S. Army Environmental Hygiene Agency conducted a close-out survey of the facility, and found that the facility conformed to the requirement of Nuclear Regulatory Commission Regulatory Guide 1.86 for unrestricted release of the facility. The license for the reactor was therefore terminated.

3.4 Shortly following the license termination, the facility was transferred to the control and ownership of WRAMC. The WRAMC Health Physics Group has been using the facility as a low level radioactive waste holding, staging, and packaging area ever since. These rad waste operations have been covered by WRAMC's NRC licenses 08-01738-02 and DARA 08-01-97. In the exposure room, which is the subject of concern for this survey, rad waste operations have been limited to holding animal carcasses and radiotherapy wastes in cold storage for radioactive decay or shipment. Radioisotopes involved included primarily H-3, C-14, I-125, I-131, Cr-51, Ce-141, and Sc-46. Radioactive wastes held in the cold room or test cell were generally contained or enclosed in plastic bags, or containerized in 55 gallon drums. Weekly surveys by WRAMC Health Physics verifies the absence of radiological contamination in the exposure room from these rad waste operations.

4. Decommissioning Activities.

4.1 Previous decommissioning activities are described in Rockwell's DORF Decommissioning Program Final Report (Encl 2) . This effort is limited to a gamma radiation survey of the exposure room. The objective of this survey is to determine whether the gamma radiation levels in the exposure room meet today's standards.

4.2 Surveys conducted by Rockwell after decommissioning included removable and fixed contamination measurement on concrete both inside and outside the exposure room, as well as neutron activation sampling of exposure room concrete. Air monitoring was conducted in the exposure room and high bay area during decommissioning activities. Radiation levels were found to be within limits for unrestricted release. As stated in Encl 3, the fixed and removable surface contamination clean-up limits that were applied meet today's limits. The water, soil, and vegetation were found to be contamination free. Interior surfaces were found to be free of removable contamination, with any fixed contamination present within limits.

4.3 Rockwell's pre and post clean-up contamination surveys did indicate significant neutron activation of the exposure room concrete and reactor pool concrete. The post clean-up levels at 1 cm from the surfaces indicated about 100 urad/hr over relatively large areas. Core samples indicated the presence of Co-60, Eu-152, and Eu-154 in the concrete, at concentrations of about 10-100 pCi/gm. Again, activation in the reinforcement bar was apparently not assayed.

5.5 Two areas were chosen as reference areas to establish background gamma radiation levels.

5.5.1 The rolling door alcove, located outside and opposite the exposure room entrance tunnel, was chosen for two reasons. First, like the exposure room, it is subterranean, with 2 and 3 plane corners. Secondly, it was most probably constructed with the same building materials as the exposure room. The disadvantage of using the door alcove is that being located within the facility, and being associated with present and past WRAMC rad waste operations, it might be subject to some concern as to whether it would serve as a suitable reference area. See Encl 6 for a scale drawing of the door alcove and originally planned measurement locations. Like the test cell, the area was gridded. To account for any effect that 2 and 3 plane corners might have on background levels, measurement locations were chosen so that the percentage of measurement in 2 and 3 plane corners would be approximately the same as in the exposure room.

5.5.2 An additional reference area was chosen outside the facility, but as close as possible to the facility. At the end of the DORF entrance road, a new parking garage has recently been constructed to serve as a bus stop. Like the exposure room and door alcove, the lower level is subterranean, with concrete walls and floors backed by soil. This areas was also gridded, and again, measurement locations were chosen so that the percentage of measurement in 2 and 3 plane corners would be approximately the same as in the exposure room. See Encl 7 for a scale drawing of the garage reference area, and measurement locations.

5.5 A BAIRD microrem/hr portable survey meter was chosen to perform the measurements. The meter procured was also equipped with a low energy window, which allows measurement of photons down to 17 keV in energy. The low energy window was not considered necessary for the survey, but was selected for other uses at ARL in the future. The low energy window was not expected to detract in any way from the validity of the survey.

5.5.1 Final survey gamma measurements are typically conducted using a uR/hr meter cross calibrated to a pressurized ion chamber (PIC). The cross calibration is necessary because of the severe difference in relative response between NaI and the pressurized gas with variations in gamma energy. It is then assumed that each microroentgens per hour measured with the pressurized gas in a particular location would result in one microrem per hour of effective dose equivalent in that location. In an area where much scattering is occurring, which is certainly the case with the concrete exposure room, the energy spectrum of photons could vary greatly from location to location, and might not match that present at the location of cross calibration. For these reasons, ARL decided to employ a relatively new technology offered by the BAIRD Microrem/hr meter.

5.5.2 The BAIRD uses a tissue equivalent scintillation detector. The detector is as sensitive as the NaI uR/hr meter, but offers the advantage that it's tissue equivalent detector allows direct measurement of effective dose equivalent rates,

School of Hygiene and Public Health. Michael Borisky has attended various NRC workshops on decommissioning, and in Nov 96, attended a 2 day NRC sponsored workshop on Radiological Surveys in Support of Decommissioning, conducted by ORISE. It was during this workshop that Michael Borisky learned of the BAIRD tissue equivalent Microrem/hr meter.

6. Survey Findings

6.1 As mentioned earlier, there was radioactive waste and a calibration source present during the survey that were not considered a significant contributor to the gamma radiation levels measured. In the event that the net gamma levels measured inside the exposure room were critically close to the 5 urem/hr criteria, an attempt would have been necessary to remove all sources during the survey. This was not necessary because of the relatively high gamma levels measured throughout the exposure room. The following is the rationale used for assessing the impact of the radioactive waste and calibration source on the survey results:

6.1.1 The reference alcove outside the exposure room tunnel is an area where short half-life radioactive waste was being held for decay. On the day that reference measurements were made in the alcove, gamma levels on contact with the waste were not significantly above background when checked with the BAIRD. Nonetheless, the waste was moved approximately 10-15 feet out of the alcove while the reference measurement were being made. As can be seen in Encl 10, the average level measured in the reference alcove was still less than that measured in the reference parking garage, and certainly well below the average level measured in the exposure room. It is therefore inconceivable that the low level rad waste outside the exposure room could have contributed to the gamma radiation levels measured inside the exposure room.

6.1.2 Also located outside the tunnel was a shielding pig containing a Cs-137 calibration source, identification number 137-Cs-002. The gross gamma level measured with the BAIRD approximately 3 feet from the pig was approximately 4.5 urem/hr. As a point source, geometry alone would reduce any gamma levels inside the exposure room many meters from the calibration source to insignificant levels.

6.1.3 The BAIRD was used to measure levels on contact with the few contaminated carcasses and therapy waste in the cold room. No discernible increase was detected in close proximity to the carcasses or waste. Furthermore, the gamma measurements were made with the carcasses and waste in the cold room, and only location F4, where 41 urem/hr was detected, appeared significantly higher that the levels generally measured in the cold room. The remainder of the measurements inside the cold room were generally lower than in the remainder of the exposure room. This was perhaps because the test cell is located along the wall farthest from where the reactor was located, resulting in a decreased level of neutron activation in that portion of the exposure room.

that the gamma dose rate at one meter from surfaces not exceed background by more than 5 urem/hr. A survey was therefore conducted to determine whether the gamma radiation levels in the exposure room meets this criteria.

7.2 Pre and post clean-up surveys conducted at the time of decommissioning indicated significant neutron activation of the exposure room concrete and reactor pool concrete. Concrete core samples indicated the presence of Co-60, Eu-152, and Eu-154 in the concrete. Activation in the reinforcement bar was apparently not assayed.

7.3 Microrem/hr measurements were made at approximately 36 inches from the floor, ceiling, and wall surfaces in the exposure room. Two areas were chosen as reference areas to establish background gamma radiation levels. A BAIRD microrem/hr portable survey meter with a tissue equivalent scintillator material was chosen for the measurements. The gamma radiation levels measured at 36 inches from the exposure room concrete easily exceeded background plus 5 urem/hr. The exposure room concrete still contains residual radioactivity. The activation is relatively uniformly distributed throughout the exposure room concrete.

7.4 ARL will make arrangements to conduct a gamma spectrometry survey in the exposure room to identify the radionuclide(s) present in the concrete. It will then be possible to determine from the associated half life whether delay and decay will offer a feasible decommissioning strategy.