Gamma Facility Restoration Operation, May 1981
After Action Report

At 1158 hours on 22 April 1981, source #2 at AFRRI's Gamma Facility jammed on a support structure of an experimental operation frame used for irradiations (see Enclosure 1). The operator evaluated the situation and notified the Head of the Radiation Sources Division in accordance with Radiation Sources Division Instruction 4-4 (see Enclosure 2). Efforts to lower the source rack using the designed downhaul capability of the source elevator failed because the support structure of the experimental apparatus was jammed under the storage rack, therefore preventing the rack from returning to the storage pool (see Figures 1-6). Notification to the United States Nuclear Regulatory Commission, USNRC, was made in accordance with 10 CFR, Part 20, Paragraph 20.403, both telephonically and by message (see Enclosure 3) and reported to the Headquarters, Defense Nuclear Agency (HQ, DNA), in accordance with DNA Instruction 7730.2D. An evaluation of the situation was made to determine the various alternatives for restoring the facility to its normal operational condition. The two basic alternatives selected were: One, flood the facility with water via the emergency fill system. The facility was designed and built to be flooded should such a situation as existed occur, thus permitting the facility door to be safely opened since the water would act as a shield to attenuate the radiation. Once the door was opened various means could be used, i.e. boat, bridge, platform, etc., to reach the sources and to physically lower them into the storage pool. Upon inspection of water samples and appropriate approval, the fill water could be pumped out and follow-up restoration work completed with the sources safely in their normal pool storage position. The second alternative was to use a remote robot system to enter the facility. This would require the construction of a shield to contain the radiation present upon opening of the shield door to enter the robot. After careful consideration of these alternatives the decision was made to use the robot system. Action was initiated to locate a suitable robot system. Contact was made with the Capitol Police Department, Washington, D.C. and the Department of Energy (DOE), Oak Ridge Operations Office, Oak Ridge, Tennessee, both of which had robot systems. Based on an evaluation and prior usage of both systems the Oak Ridge System was selected. Coordination was made with the Oak Ridge DOE personnel and an operator and an engineer for the system came to AFRRI to evaluate the feasibility of using the robot system to accomplish the required tasks. After observing the situation and coordinating with the AFRRI staff, the Oak Ridge personnel felt that the robot system could be used in the Gamma Facility restoration operation. The AFRRI staff, in conjunction with input from the Oak Ridge personnel, developed a comprehensive plan to be used for the restoration operation (see Enclosure 4). The plan was reviewed by the Reactor and Radiation Facility Safety Committee and approved with some minor modification (see Enclosure 5). The plan was also sent to USNRC Region I, DOE Oak Ridge, and Headquarters, Defense Nuclear Agency for comment and/or concurrence as applicable. Required plans and coordination were finalized and the following actions were taken:

Coordinated arrival of robot system and support personnel from Oak Ridge.

Installed power line 208/240 20 amp single phase for robot system (east side of AFRRI).

Gamma Facility emergency fill system checked by NNMC Fire Department.

Required AFRRI support personnel for the operation identified and tasked as applicable.

Prepared BOM for operation and requisitioned materials not on hand.

Gamma Facility service elevator electrical controls relocated to console control room.

Close circuit television system with video tape capability installed and checked.

Communications system installed between control points.

Shield door marked to identify position.

Physical door stop for shield door installed in door-well cave.

Entrance ramp designed, fabricated and installed along with lowering/raising system.

Door shield cave designed and constructed.

The above tasks were some of the main points required in preparation for the restoration operation.

On 14 May 1981, the Oak Ridge robot system support personnel arrived at AFRRI, one engineer and one operator. They, along with the AFRRI staff, and xx xx xxx, Oak Ridge National Laboratory, Oak Ridge, Tennessee, discussed the planned operation. On the morning of 15 May 1981 final preparations for the operation were taken to include various tests of the robot system. One key concern of the robot system personnel was the CCTV lenses of the robot. It was estimated that the robot's TV cameras could be in a 35,000 R/hr field at various times during the operation. Consideration was given to the use of some radiation hardened lens cameras on the robot. Tests with these cameras did not provide the desired resolution for the robot operation. After some discussion and based on information available, it was decided that the radiation levels of exposure to the robot would not significantly effect the existing lenses and the robot was moved into the shield cave for staging. Control cables leading from the robot to the control trailer were run through a 4" I.D. conduit located on top of the north side of the shield cave. With the robot in place the shield cave construction was completed and a test of the shield was conducted at approximately 2330 hours (see Enclosures 6 and 7). Since the test was completely successful the restoration operation was scheduled to proceed at 0900 hours on 16 May 1981.

At 0925 hours on 16 May 1981 the Operations/Safety Briefing was completed and the operation proceeded in accordance with the plan and checklist (see Enclosures 7 and 8). At 1315 hours on 16 May 1981 the storage rack, with all sources intact, were safely in their storage pool position. The shield door was fully opened at 1331 hours and a Radiological Safety Survey Team entered the facility at approximately 1340 hours (see Enclosure 7). No readings above background were detected, nor was there any other radiological hazard existent within the room. Water samples were taken, again with negative results. With the facility in a safe condition the operation was terminated. The facility was opened to the appointed investigating officer for his on-site inspection. Upon completion of this inspection the facility was open to the media personnel accompanied by the Defense Nuclear Agency's Public Affairs Officer and AFRRI staff members. The facility was then secured until normal duty hours on 18 May 1981 when follow-up action took place. The USNRC Region I representative on-site confirmed successful completion of the operation and indicated that no confirmation of the same was required by AFRRI to the USNRC Region I Office. A close-out report, a copy of this After Action Report along with a cover letter, is required by USNRC Region I, and will be sent upon review and approval by the Radiation Research Facility Safety Committee.

After lengthy discussion of the incident by the AFRRI staff, based on all information available, the following cause of the malfunction is proposed. Prior to the implacement of the electronic

components to be irradiated the operator raised and lowered the sources twice with the experimental support frame apparatus in place with his dosimetry chambers on top. This was done to acquire a dose rate and the rise and fall dose. No problems were encountered at that time. Upon the implacement of the electronic components to be irradiated the frame support may have been slightly moved in such a manner, that when the sources were raised for the irradiation the top of source rack #2 caught under the upper portion of the experimental frame. This in turn caused the bottom of the frame to be pulled up, and in towards, the elevator mechanism #2. With this being true the support structure which is approximately midway up the experimental frame would have been under the source rack #2 and when the source scram was initiated the bottom of the rack would have impacted on the top of the support structure as observed in the incident. Although this can only be speculated it seems that this is the most likely scenario that could have occurred. Additionally, the vertical support member on the east side of the frame apparently, (from photo via CCTV), came to rest on the brake handle and could have released the brake and applied sufficient pressure on carriage #2 to cause it to be pulled, approximately 5 inches, into carriage #1.

Follow-up action was initiated on 18 May 1981 to restore the facility to an operational condition. This included:

Installation of new drive motor for elevator #2.

Installation of new drive pin, attach motor to clutch, for elevator #2.

Installation of new microswitch for bottom light, elevator #2.

Installation of new microswitch for bottom light, elevator #2.

Installation of new microswitch for top light, elevator #2.

Brakes on elevator #2 carriage adjusted.

Brakes on elevator #4 carriage checked.

Replaced up-haul cable, elevator #2.

Replaced downhaul cable, elevator #2.

Removed outriggers from cassette storage racks from elevator #1 and #2. (Source racks can now accomodate only four (4) cassettes in rear position only).

Adjusted cables on elevator #1.

Entire source elevator mechanism inspected for damage or unusual wear.

Shield door interlock replaced and checked.

Downhaul circuits returned to normal mode.

Facility service elevator controls restored to normal state.

Console electronics checked to include interlock/scram circuits (see Enclosure 9).

Both source elevators (empty) raised and lowered in manual and automatic modes.

Water samples taken and analyzed (see Enclosure 7).

Leak test performed on all Cobalt 60 ribbons, 24, that were in the storage rack (see Enclosure 7).

*USNRC Region I has been contacted and has stated that they have no additional requirements from AFRRI, other than the aforementioned close-out report. The facility is authorized to be operated in accordance with our license and applicable regulations.

Additionally, the following planned actions will be completed after review by the Reactor and Radiation Facility Safety Committee, and prior to operation of the facility:

All interlocks scrams will be physically tested (see Enclosure 9).

When possible all experiments will be performed at the north end of the facility. (This will cut down the angle of the radiation for opening of the shield door should a similar incident ever occur.)

Modify electronic experiment support frame apparatus. Modification includes the fastening of the vertical frame members to the steel angle lip which runs parallel to the storage pool. A two inch (width) metal bar will extend across the pool on top of the steel lip, thus preventing the two carriages from coming in contact with each other. This would permit the free travel of the source racks, in their normal path, at all times. No intermediate cross member will be used for support, i.e., elimination of the support cross member that was jammed.

Other actions being considered and evaluated include:

Redesign cassettes to accomodate up to 10 ribbons. (This would restore the capability to provide higher dose rates since the outriggers holding four additional cassettes have been removed.)

Modify the brake system to include a lock-on/lock-off capability.

Design and install guard for cable take-up reel.

Design and install an electronic winch system. Winches would be located at north and south end of the pool with cables attached to source elevator carriages. This would provide a capability for remote horizontal travel of the source elevators.

Design and install motorized horizontal drive systems for source elevator carriages.

Upgrade CCTV system.

Design and install overhead crane system with control capability from console control room.

Based on the speculated cause of the incident, it is felt that the planned action would remove the possibility of a similar occurrence. Additionally, the written operational procedures are

currently being reviewed to insure they are adequate. Additional instructions/procedures will be implemented if required.

Additional information to include cost data for work accomplished will be added to this report upon receipt.