1. SITUATION

Since 1158 Hours, 22 April 1981, source elevator #2 at AFRRI's gamma facility has been jammed on an experiment support apparatus. A total of approximately 24,000 curies of Cobalt 60 are loaded in the elevator storage mechanism which is about 2.5 feet above the storage pool. The Cobalt 60 sources are in the form of doubly encapsulated stainless steel ribbons, 13" x 1" x 1/8". The ribbons are loaded in cassettes, six (6) ribbons per cassette. There are a total of four (4) cassettes, or twenty-four (24) ribbons in the source elevator storage mechanism. All efforts using designed systems to remotely free the jammed elevator have failed. The facility was designed to house 500,000 curies of Cobalt 60, therefore no radiological safety hazard exists. The exposure room is 35' x 35' x 25' 8". A 10' cubical room is attached on the southeast section of the exposure room. The cubical is open on the connecting side. The facility was designed to be flooded if necessary.

2. GENERAL.

During the entire restoration operation a comprehensive radiological safety monitoring plan will be in effect to insure that radiation levels do not exceed those proposed. A closed circuit television system will be used to monitor, and assist in conducting, this operation. Three separate areas for required remote operations will be established. One, the Robot Control Console located in a trailer, staged outside the third floor, east side of the AFRRI complex. Two, the Cobalt Console Control Room located immediately outside the Cobalt facility. Three, the Closed Circuit Television Control Room located on the second floor of the AFRRI complex. A communications network will be established between these three points with a pre-designated spokesperson at each site.

3. COMMAND & CONTROL.

Command and Control of the overall restoration operation will be under the direction of the AFRRI Directorate. The Directorate designee will be located in the CCTV Control Room and will provide guidance and command decision as required. He will have communication with the two other operational control points and will coordinate and control all operations. All CCTV camera operations for the two facility cameras and the planned shield cave camera will also be accomplished from this point. The robot system operator, along with two AFRRI technical personnel, will be located in the Robot Console Control trailer. Actual control and manipulation of the robot and its designed system will be accomplished by the operator from this point. The third operational control point is located at the Cobalt Console Control Room and will be manned by a qualified Cobalt facility operator as well as safety and support personnel. Operations which will be carried out from this area will include opening/closing of facility shield door, lowering/raising of entrance ramp and the lowering/raising of the facility elevator. As previously stated, all operations will be coordinated and controlled by the Directorate designee.

4. SUMMARY OF PLAN

The restoration of the Cobalt 60 facility will be accomplished by using a robot system to enter the facility and lower the source. Multi-section radiation shields, constructed of concrete and lead will be used to reduce radiation levels in the immediate area to <10 mR/hour. Radiation levels outside the AFRRI complex will not exceed that for unrestricted areas, 2 mR/hour, at any time during the restoration operation. With radiation shields in place and the robot prepositioned in its shield staging area, the door will be opened. A ramp will be lowered across the door-well to allow the robot to move into the facility and onto the service elevator platform. Once on the service elevator the robot will be remotely lowered to the facility floor level. CCTVs will be used to monitor all operations. Upon reaching floor level the robot will be remotely positioned near the jammed source elevator mechanism and will attempt, not necessarily in this order, one of the following operations:

a. Approach source elevator #2 from the south. Release elevator carriage brake. Grasp source elevator storage rack above source cassettes and raise 10" to 12". With storage rack up, pull carriage back toward south wall and attempt to dislodge jammed support frame member from the undersurface of the storage rack. First lower then release the rack allowing it to drop into storage pool.

b. Approach source elevator #2 from the south. Place snubber on elevator up-haul cable. Raise source storage rack 10" to 12". Secure cable with snubber to keep source rack positioned so it is not resting on the jammed support frame cross-member. Grasp jammed support frame member and remove it from under source storage elevator rack. Release or cut up-haul cable allowing source rack to drop into storage pool.

c. Approach storage elevator #2 from south. Release elevator #2 carriage brake. Grasp elevator #2 storage rack above source and pull towards south wall about five (5) feet. Release rack. Reposition robot to approach source elevator #2 from the north. Attach winch cable to jammed support frame cross-member. Change robot's finger attachment and replace with cutting hook. Using cutting hook attempt to cut jammed support frame on west side. Attempt to cut jammed support frame on east side. Have robot grasp source elevator storage rack above source. Raise source storage rack and take up slack on winch cable in an attempt to remove cut section of jammed support frame cross-member structure. Lower, then release source rack allowing it to drop into storage pool.

d. Approach source elevator # 1 from north. Release elevator # 1 carriage brake. Grasp carriage #1 and pull toward north wall, moving approximately six feet away from elevator mechanism #2. Release elevator carriage #1 and approach elevator carriage #2 from the north. Remove front two cassettes using robot's fingers and place in wire basket. Using fabricated hooks remove remaining two cassettes and place in wire basket. Attach robot's winch to wire basket handle. Have robot lift basket and deposit it over storage pool. Reel-out on robot's winch allowing wire basket with source to be lowered to bottom of storage pool.

The above operations were worked out with personnel from Oak Ridge who control and operate the robot system. Both an operator and engineer visited the AFRRI site and, in conjunction with AFRRI personnel, developed the above scenarios. Various experimental tests and operations to determine the ease and ability of the robot to perform the planned operation are currently being conducted by the Oak Ridge personnel. Based on their findings and existing facts, the decision as to which operation will be attempted first, will be made. During the course of conducting any selected operation, a decision to alter from the planned action can be made by the Command and Control element if it is determined that such alteration would be advantageous to the restoration operation. Actual detailed manipulations of the robot will depend on existing circumstances as each action is taken.

5. SHIELD DOOR OPERATION

a. General: In order to permit the robot to enter the cobalt facility the shield door must be partially opened. If necessary, provisions exist to close the door to within six (6) inches once the robot is on the facility service elevator. Care will be taken during all operations of the door to insure there will be no radiation levels above those proposed. Also, care will be taken to insure robot cables will not be tangled, smashed or cut by door operations.

b. Opening: Once all shielding is in place and coordination for the door opening has been accomplished, the Command & Control element will authorize the door to be opened. Actual opening will be accomplished from the Cobalt Console Control Room. Both CCTVs inside of the Cobalt 60 room will be focused on the door. The CCTV positioned inside of the robot staging area will also be on the shield door as well as the two CCTVs which are located on the robot itself. Hand held detectors will be used to monitor radiation levels in the immediate area as well as outside areas. Initial opening will be accomplished by moving the door in steps of approximately six (6) inches to allow radiation surveys to be taken, insuring integrity of constructed shields.

c. Closing: (Should the need arise) Once the robot has crossed over the shield doorwell via a ramp and onto the service elevator, the ramp will be recovered and the door will be closed. Care will be taken to insure the robot's cables will be free at all times. This will be accomplished by taking up the slack in the cables which will be fed through a 4" I.D. pipe located approximately seven (7) feet above the bottom of the door and through the radiation shield. The robot will be holding its end of its cables in its finger attachment upon entering and will continue to hold, and manipulate the cables if required, until it is on the facility service elevator. The door closing will be monitored via CCTV and prepositioned control marks which will be located on the door to indicate its exact position, thus insuring it does not close on the cables.

6. ENTRANCE OF ROBOT.

In conjunction with the shield door operation the robot will be remotely moved into the facility, onto the service elevator and lowered to the facility floor level. Prior to entry

the robot will be staged within the shield area itself (hereafter referred to as shield cave). It will be positioned in such a manner as to allow it to enter the facility via a steel ramp which will be lowered into place once the door is opened. The steel ramp will be pre-positioned in the shield cave and hinged to the floor area outside the facility shield door. The ramp will be manually lowered using a pulley system from outside the shield and can be retracted, if necessary, to allow the door to be closed as previously mentioned. A CCTV camera will be installed within the shield cave and along with the robots two cameras, and existing facility cameras, will permit monitoring of the entrance operation. When the robot is positioned in the shield cave it will hold its end of the cable in its finger attachment. The cables will be fed through a 4" I.D. conduit running through the north side of the shield approximately 7 feet from the bottom of the door. Once the door has been opened, the ramp lowered, and the robot has entered the facility, the robot will position its cables out over the stairway rail to prevent any tangles or snagging of the cables. It will then manipulate the removal of an open-end hook and chain to allow its access onto the service elevator. Once on the service elevator it will be remotely lowered to the facility floor level and positioned for operation.

7. RADIATION SHIELD.

A multi-section radiation shield will be constructed of lead and concrete blocks to attenuate the radiation resulting from the opening of the facility shield door. The shield will have a basic "U" shape with the open end facing the facility door. A roof section will be constructed over the open top, at approximately 66 inches from the floor level, thus forming a cave. The roof will consist of a steel plate with appropriate structural members as to support the required lead shielding to be placed on its top. The steel plate will have concrete blocks under three of its edges as bearing surfaces and will extend far enough over these surfaces to facilitate its designed purpose. A 4 inch I.D. conduit will run through the shield on the north side to accept the robots cables. Two other penetrations will be required in the cave roof for the pulley system cables that control the manipulation of the entrance ramp. The basic concept design of the shield and its position in relationship to the facility shield door are illustrated in Appendix A. Modifications will be made, if required, while construction of the shield is in progress; however, radiation levels will not exceed those previously proposed.

8. ENTRANCE RAMP.

An entrance ramp will be constructed to span the shield door well once the door is opened. It will be designed to carry the robot load 1,800 pounds (Appendix B) and will be prepositioned in the shield cave. It will be hinged to the floor area outside the facility shield door and will be manually lowered into position via a pulley system from outside the shield area. The ramp system will be designed in such a manner as to allow it to be retracted, if necessary, in order to permit the door to be closed.

9. CONTINGENCY RESPONSE.

Should the need arise, the Cobalt facility is designed to be flooded with water via an emergency fill plug located outside the facility. The plug and fill system have been checked, and coordination for this requirement has been accomplished with the National

Naval Medical Center's Fire Department.

10. RESTORATION FOLLOW-UP.

After the Cobalt 60 sources are returned to their normal pool storage position, and it has been determined that no radiation hazard exists, the Command & Control element will authorize the shield door to be fully opened. A survey team will enter the facility and take appropriate measures to include surveys & wipes, to insure no undetermined radiation hazard exists. A designated investigating officer will review the situation prior to the initiation of action required to return the facility to an operational status. A leak test will be conducted on all Cobalt source ribbons involved in the incident. Appropriate operational and administrative actions will be taken to preclude reoccurrance of a similar situation. Required data and after-action reports will be prepared and submitted to appropriate agencies.