FINAL REPORT

SHIELDING INTEGRITY CHECK (SIC) TESTS FOR THE E-MAD FACILITY

(PHASE II AND PHASE II ADDENDUM)

MASTER

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FINAL REPORT

March 1966

Report NTO-R-0062

Shielding Integrity Check (SIC) Tests

for the

E-MAD Facility

Phase II and Phase II Addendum

Contract SNP-1

MASTER

Prepared for

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FOREWORD

This report is presented in partial fulfillment of Contract SNP-1, Sub-subtask 7.5.1 for Contract Year 1965 and 1966, which states in part, "Complete Shielding Integrity (SIC) Tests for shielded walls (except for Postmortem intercell walls), analyze and evaluate the results relative to program requirements and provide for minor facility modifications to correct deficiencies".

ABSTRACT

This report contains the data and results obtained from the Phase II Portion of the Shielding Integrity Check (SIC) Tests at the E-MAD building. This portion of the SIC tests was performed by NERVA Test Operations (NTO) under contract SNP-1, Sub-subtasks 7.5.1 and 7.5.2.

The Phase II Portion, the Postmortem cell walls (except for the Postmortem Intercell walls), and the Phase II Addendum Portion, the mating surfaces of the shielding door 173-1 between the Cell Service Area (CSA) and Room 176, were performed to disclose any defects in shielding which might be present. The violations of shielding integrity found were corrected by physical repair (construction contractor fixed), or by the establishment of administrative controls to be enforced during an operational phase, depending upon the severity of the violation.

There were four (4) violations of shielding integrity found in the Phase II Portion of the SIC tests. One (1) of these violations was of sufficient magnitude to require a construction contractor type fix, and three (3) violations will require only the administrative type operational controls to assure personnel safety. The one (1) violation requiring a construction contractor type fix was repaired by the contractor and rechecked.

The repaired violation was found to possess adequate shielding integrity.

There was one (1) violation of shielding integrity found in the Phase II Addendum Portion of the SIC tests which will require only the administrative type operational controls to assure personnel safety.

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I. INTRODUCTION

The purpose of performing the Shielding Integrity Check (SIC) Tests is to determine the radiation shielding capabilities existent in a particular shielded zone by a technique which will enable the detection, pin-pointing of exact location, and quantitative evaluation of any shielding defect so that corrective action can be taken to insure the safety of personnel working within that area. There is no attempt to determine or evaluate the structural integrity of the facility as a part of these tests.

The total scope of work required for performance of Shielding Integrity Check (SIC) Tests for all of E-MAD was divided into five (5) distinct phases as follows:

1. Phase I - The Hot Disassembly Area consisting of Hot Bay (Room 122) and the Crane Maintenance Balcony (Room 306).
2. Phase II - The Postmortem Cells
3. Phase III- The Hot Hold and Transfer Tunnel (HHTT) and Cell Service Area (CSA).
4. Phase IV - The Postmortem Intercell Walls
5. Phase V - The Engine and Core Disassembly Cells

After this initial division had been made, it was decided that an addendum to the Phase II portion of the SIC tests be made which would encompass the scanning of the area around the shielding door 173-1 adjacent to the viewing windows S-101 and S-102 since personnel might be stationed at these viewing locations during operations.

This report describes and details the results of the Phase II portion of the Shielding Integrity (SIC) Tests, the Postmortem Cell Walls (except for the Postmortem intercell walls), and the Phase II Addendum portion of the SIC Tests, the shielding door 173-1 as described in the paragraph above (Figure 1).

The procedure for the conduct of the SIC Tests of these zones was issued previously as a separate report which provided detailed instructions for performing that portion of the work concerned with mapping and indexing of all surface areas to be surveyed; the scanning of these areas with a radioactive source monitored by radiation detectors; and for the evaluation of the results followed by a subsequent recommendation for the correction action to be taken.

In addition to the above procedure, an E-MAD Standard Operating Procedure (SOP) Safety Standard No. 1 was issued to cover the responsibility and safety considerations involved in the use of a high-level source at E-MAD.

II. SUMMARY

The Phase II portion of the Shielding Integrity Check (SIC) Test disclosed four (4) violations of shielding integrity. One of these violations required a construction contractor fix, and three (3) violations will require only administrative type operational controls.

The violation which required a construction contractor fix consisted of voids in the concrete walls of Postmortem cells 163 and 164, adjacent to triads of stepped pass throughs (Figure 3). These voids were filled with lead shot and subsequently rechecked for shielding integrity. The repaired areas were found to be satisfactory.

The three (3) violations which will require administrative type operational controls result from various pass-throughs where radiation can be made to "shine" through by proper placement of the source.

The first of these is involved with the intercell transfer system door cranks (Figure 2). The design allows a small gap to exist between the crank and pass-through. This design deficiency will be corrected during installation of electric powered door mechanisms. Administrative operational control will be maintained in these areas until such time as the new system has been installed.

The second violation results from highly collimated radiation shine through the postmortem cell master-slave manipulator openings. The streaming is variable depending upon manipulator position and since it occurs at a considerable elevation, a fix is not required. Administrative controls will be maintained in these areas.

The third violation occurs as the result of the routing of a tetrad of conduits which pass from the postmortem gallery to the lateral face of the intercell wall (Figure 4). The conduits were installed as designed and no contractor fix is required. NTO will plug these conduits and will provide shielding with any cabling to be routed through these conduits.

The Phase II Addendum portion of the SIC Tests was concerned with the check of door 173-1 which closes off the cell service area at the south end. This check indicated that radiation passing through this door on a bias could expose personnel stationed in the south cell service area to minor radiation levels. The exposure to personnel will be limited by maintaining administrative type controls in this area when radioactive material is located in the Cell Service Area.

III. TEST DATA AND RESULTS

The Shielding Integrity Check (SIC) Tests conducted for the Phase II portion of the work disclosed a total of four (4) violations and one apparent violation. One of these violations required a contractor type fix and the other three (3) will require only administrative type operational controls. The apparent violation consisted of pass-throughs which were temporarily filled with lead bricks. The violations and apparent violation are shown in Table 1. :

A detailed tabulation, shown in Table II, was made to provide additional information on the average readings, range, and basis for constituting a violation for various areas tested.

The SIC tests of the Phase II Addendum portion of work disclosed a violation which existed as a result of the design of door 173.1. The clearance between the door and the wall was sufficient to allow a radiation level up to 15 mR/hr to exist in the south observation gallery area. The results of the SIC test of this area are shown in Figure 5. Administrative type operational control of this area will be required during hot operations.

TABLE I
VIOLATIONS AND APARENT VIOLATIONS IN PHASE II SIC TEST

Violation	Elev. Above Floor	Number of Examples	Radiation Passing Through Violations*	Equivalent High Density Concrete Missing**	Comments	Suggested Fix
Crank Holes All Cells	2'	20	Up to 0.15 mR/hr	1.5-1/10 layers or 7.5 in.		Replace manual drive with motor drive. Motor and coupling will supply sufficient shielding to preclude fix.
Master Slave Manipulator Cells 160-166	10'	18	From small amount up to 600 mR/hr	Approximately 5-1/10 layers or 25"	Beam was highly collimated and maximum readings were difficult to reproduce	Administrative Control
Triad of 5" x 4" Stepped (Plugged Pass Throughs Cells 163 & 164)	4'	2	175 mR/hr	Approximately 4-1/10 layers or 20"	It was established that even though the presence of the triads caused the defect, the repair of the defects does not involve the triad.	Fix is complete. The voids were located by radiography. On re-check the radiation passing through the violation equals that in the surrounding areas.
Tetrad of 2" conduits	6'	11	Up to 25 mR/hr	N/A	The empty conduits as seen by a bias located source will allow streaming which exceeds the maximum allowable levels	Administrative Control
Holes in the south walls of Cells 165 & 166 which were temporarily filled with lead brick	4'	3	Up to 1 mR/hr	N/A	Areas in 165 have since been filled with microhardness and metallograph equipment. (This was not considered as a violation).	Administrative Control

*Average value of radiation passing through an adjacent zone was 0.01 mR/hr.

** Amount of concrete which must be added to bring shielding integrity to 45" high density concrete wall.

TABLE II
AVERAGE GAMMA PENETRATION READINGS FOUND IN THE VARIOUS AREAS
(Source strength approximately 1600 Curies)

Location	Average Reading	Range of Reading Excepting Violation	Minimum reading which would constitute a violation	Comments
East and West Cell Faces	Background 0.015 mR/hr	Background (Approximately 0.015 mR/hr)	0.075 mR/hr	See tabulation of violations for violations found in this area.
North Walls Cells 160 & 167	Background only approximately 0.015 mR/hr	Background only (0.015 mR/hr)	0.075 mR/hr	2 mR/hr leaked around ITS Door, Room 127, 15 mR/hr leaked around and/or through ITS Door, Room 130
South Wall Cells 165 & 166	Background only approximately 0.015 mR/hr	Background only approximately 0.015 mR/hr	0.075 mR/hr	1, 13 and 15 mR/hr leaked thru cracks between places where lead bricks were used to plug temporary holes in the wall. The holes were left in the walls for the metallograph, microhardness tester, etc.
<u>Ceilings</u> 8' x 8' cells 8' x 16' cells	0.24 mR/hr Background only approximately 0.015 mR/hr	0.02 to 0.8 mR/hr Background only approximately 0.015 mR/hr	1.2 mR/hr 0.075 mR/hr	Concrete on 8' x 16' cell ceilings is 5'2" thick (Cells 160, 161, 167 and 168. Concrete on 8' x 8' cells is 4'1" thick (all other cells)

IV. ANALYSIS OF DATA AND CORRECTION OF DEFECTS

In order to evaluate and analyze the data and results obtained from the conduct of the Shielding Integrity Check (SIC) Tests, it was necessary to establish a basis for determining the level of reading which would constitute a violation. This requirement was met by establishment of the following standards and ground rules which were agreed upon by the Test Evaluation Committee (TEC):

1. A maximum reading of five (5) times or less than five (5) times the average level which would be observed through walls known to possess adequate shielding integrity with a source in position will not be considered as significant.
2. A maximum reading greater than five (5) times the average of adjacent or similar construction is considered a violation unless the reading is commensurate with structural design.
3. In those cases where the shielding integrity is in apparent violation, but is commensurate with the design, administrative control will be employed.
4. If the apparent violation is not commensurate with the design, then a fix by the construction contractor would be required.

Based on the above standards and ground rules, an evaluation and analysis of the test results obtained for the various areas were made. This analysis and the resolutions agreed upon by the Test Evaluation Committee (TEC) are summarized in the following paragraphs:

Shine Through the 20 Crank Holes for ITS Pass-Through Doors

There is a clearance of 0.031 inches between the shaft that leads from the crank to the door and the sleeve that contains the shaft (See Figure 2). The radiation "shine" through this clearance reached 0.15 mR/hr. There are twenty such devices in the 12 P.O. Cells. Since it is planned to design a motorized drive for these cranks, the design will reflect the shielding requirements necessary to correct the shielding inadequacy. Until the new system is installed, administrative control of these areas will be maintained and no contractor repair will be required.

Master Slave Manipulators

Varying amounts of "shine" (up to 600 mR/hr) passed through the holes in the shielding walls containing the MSM's. The beams were highly collimated, and some of the high readings which were found on the initial scan could not be reproduced on re-scan in a reasonable length of time. Investigation of the construction of the MSM's indicates that a slight variation in the position of the tie rods, tapes and cables which pass through the shielding wall can open or close a path for radiation. Because of the high elevation of this potential streaming, a fix is not required and administrative control over these areas will be maintained.

Fourteen of the 16 MSM sleeves on the east wall have concrete plugs instead of manipulators installed in them. Some of these plugs and sleeves had to be ground to fit before the plugs could be installed in the sleeves. Up to 0.3 mR/hr of radiation could be made to pass through these areas. Since these cells will not contain materials until MSM's are installed, no construction fix will be required.

Triad of 5" x 4" Stepped Pass-Through

The triads (See Figure 3) of 5" x 4" stepped pass-through are in an area which is full of conduit and re-bar. This condition made it very difficult for the contractor to accomplish a solid pour of concrete. The triads in Cells 163 and 164 showed leakage of radiation which indicated that as much as twenty inches of high density concrete were missing. The construction contractor was notified that a fix was required, and he performed drill-and-fill operation using #8 Pb shot fill. (948 lbs). A re-check of these areas with the Cyclops source gave the following maximum readings: Cell 163 - .025 mR/hr and Cell 164 - .05 mR/hr.

The repaired walls were accepted as within tolerance of less than 5 times the radiation readings of surrounding areas.

Tetrad of Conduit

At each intercell wall there is a set of four conduits that go from the gallery to the lateral face of the intercell wall. (See Figure 4) The source can be set in such a position that radiation can be made to enter and leave the conduit on the bias. This results in a marked reduction of shielding. Radiation readings in this area reached 25 mR/hr. Since the conduits were installed as designed, no contractor fix is required. NTO will plug the conduit as required.

Stray Radiation Passing from the CSA (Room 173) through Door 173-1 and into the South Gallery

In order to define the radiation hazard to personnel stationed at the windows south of the Cell Service Area due to radiation from sources within the cell, a special experiment was run. The cyclops source was placed successively near the cracks between Door 173-1 and the adjacent wall east of the door (Position 1) and the adjacent wall west of the door (Position 2) as shown in Figure 5.

The resulting radiation levels in the south observation galleries reached 15 mR/hr. Since the door was installed as designed, no contractor fix was required. This area will be placed under operational administrative control during hot operations involving the Cell Service Area.

V. CONCLUSIONS

The conduct of the Phase II portion of the SIC Tests was satisfactorily completed. All the violations have either been satisfactorily corrected or can be treated by the establishment of appropriate administrative type controls.

The establishment of administrative type controls would consist of such things as marking of areas, color coded zoning, a temporary erection of appropriate barricades and/or the direct employment of personnel to monitor access to a particular area during the time the operations are in progress. These administrative controls would be maintained "as and when needed" to adequately assure personnel safety and will be covered in appropriate operating procedures.

The violations concerned with the Intercell Transfer System Door Mechanisms are expected to be corrected by the addition of shielding as a part of the electric door drive mechanisms.

The conduct of the Phase II Addendum portion of the SIC Tests was satisfactorily completed and the possibility of minor radiation exposure to personnel in the south operating gallery has been identified. These area will be operated under administrative type controls during hot operations.

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4. E-MAD Standard Operating Procedure Safety Standard No. 1, Issued 10 December 1964, Revision A.
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FIGURE I

NERVA TEST OPERATIONS
 NUCLEAR ROCKET DEVELOPMENT STATION
 Jackass Flats, Nevada

INTERCELL TRANSFER SYSTEM
DOOR MECHANISM RADIATION
LEAK

FIGURE 2

NERVA TEST OPERATIONS
NUCLEAR ROCKET DEVELOPMENT STATION
Jackass Flats, Nevada

SHOT BEING APPLIED TO CAVITY OF TRIAD PASS-THROUGH VIOLATION

FIGURE 3

CELL SERVICE
AREA
ROOM 173

PLAN VIEW
WEST GALLERY

TETRADS OF CONDUIT PASS-THROUGHS

FIGURE 4

The general direction of the source beam was biased such as to generate the worst possible condition.

FIGURE 5