

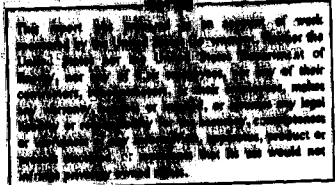
DESIGN, FABRICATION AND MOCKUP TESTING IN THE  
REMOTE MAINTENANCE DEVELOPMENT FACILITY

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## ABSTRACT

The Remote Maintenance Development Facility (RMDF) at the Idaho National Engineering Laboratory (INEL) was installed and used extensively for full-scale development, mockup and testing of remote maintenance requirements for the New Waste Calcining Facility (NWCF). By performing remote handling tests, the NWCF handling concepts, techniques and remote capabilities were proven workable prior to construction.

Presented in this paper is a description of the RMDF and its purpose, functions, and handling capabilities as they were used in support of the NWCF.

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## INTRODUCTION

During conceptual design of the New Waste Calcining Facility (NWCF) a Remote Maintenance Development Facility (RMDF) was established at the Idaho National Engineering Laboratory (INEL) for full-scale development, mockup and testing of remote handling equipment, systems, methods and techniques for the NWCF. Through efforts at the RMDF, remote handling and maintenance requirements for the NWCF have been identified and proven workable during the design stages of the project.

Initial work at the RMDF included (a) development of process and electrical connectors which were compatible with both process and remote equipment requirements, (b) full-scale mockups for dimension determinations, and (c) viewing and reach measurements for optimum handling conditions. As facility design progressed, and as building configurations and equipment were defined and identified, full-scale process equipment mockups were then installed in the RMDF for development of remote handling techniques.

Specific tasks and purposes of the RMDF as used in support of the NWCF remote design included the following items.

1. Development of process connectors, electrical connectors, handling fixtures, equipment assembly guides and transfer equipment.

2. Proof of conceptual design for valve assembly replacement, process filter replacement, pump replacement, vessel spray nozzle replacement and liquid, gas and solids sampling.
3. Full-scale mockup and testing of Title I and Title II designs for viewing requirements, space requirements, reaches, maintainability of support equipment and handling techniques.
4. A training facility for operating and maintenance personnel.

The RMOF has the capability of demonstrating remote handling techniques which will be used in a valve corridor equipped with an electromechanical manipulator, overhead cranes and shielded viewing windows, and in process cells that will use master-slave manipulators, bridge-mounted manipulators and overhead hoists.

#### DESCRIPTION

The RMOF consists of two general test areas. One area is a simulated valve corridor where process valves, meters, small pumps and filters may be located for accessibility and visibility testing during replacement by remote handling equipment. The simulated corridor (Figures 1 and 2) is 18.3 m (60 ft) long, 12.2 m (40 ft) high, which allows an effective mockup wall height of 10.7 (35 ft) and 3.0 m (10 ft) wide, and processing equipment may be placed at any location (horizontal or vertical) along the mockup wall and still be within the reach and handling capability of the remote equipment.

Remote equipment and auxiliary support devices associated with the valve corridor include a wall-mounted electromechanical manipulator (PaR Model 2000) rated at 68 kg (150 lb) at the hand with the manipulator elements in any position. All manipulator motions are electrically

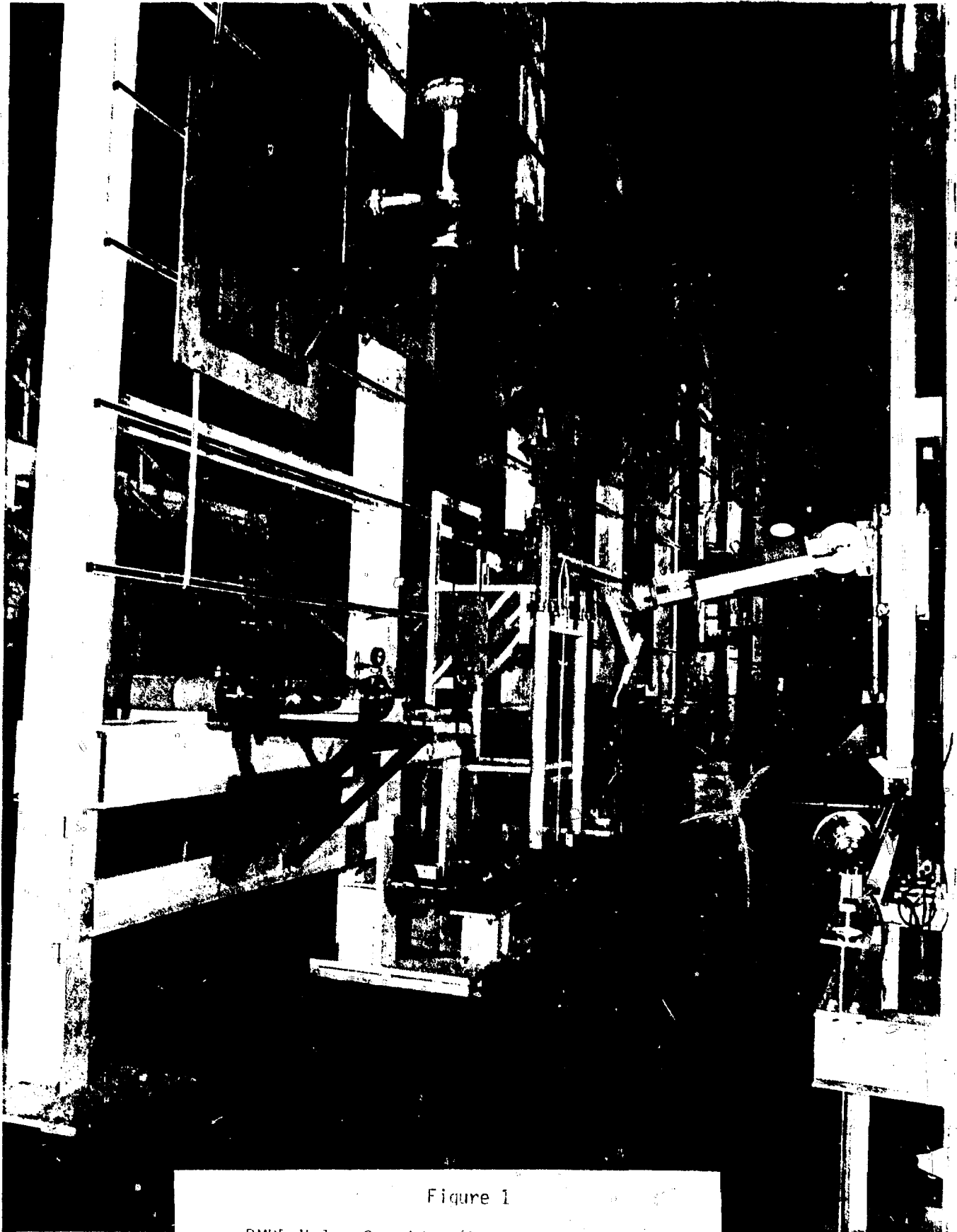
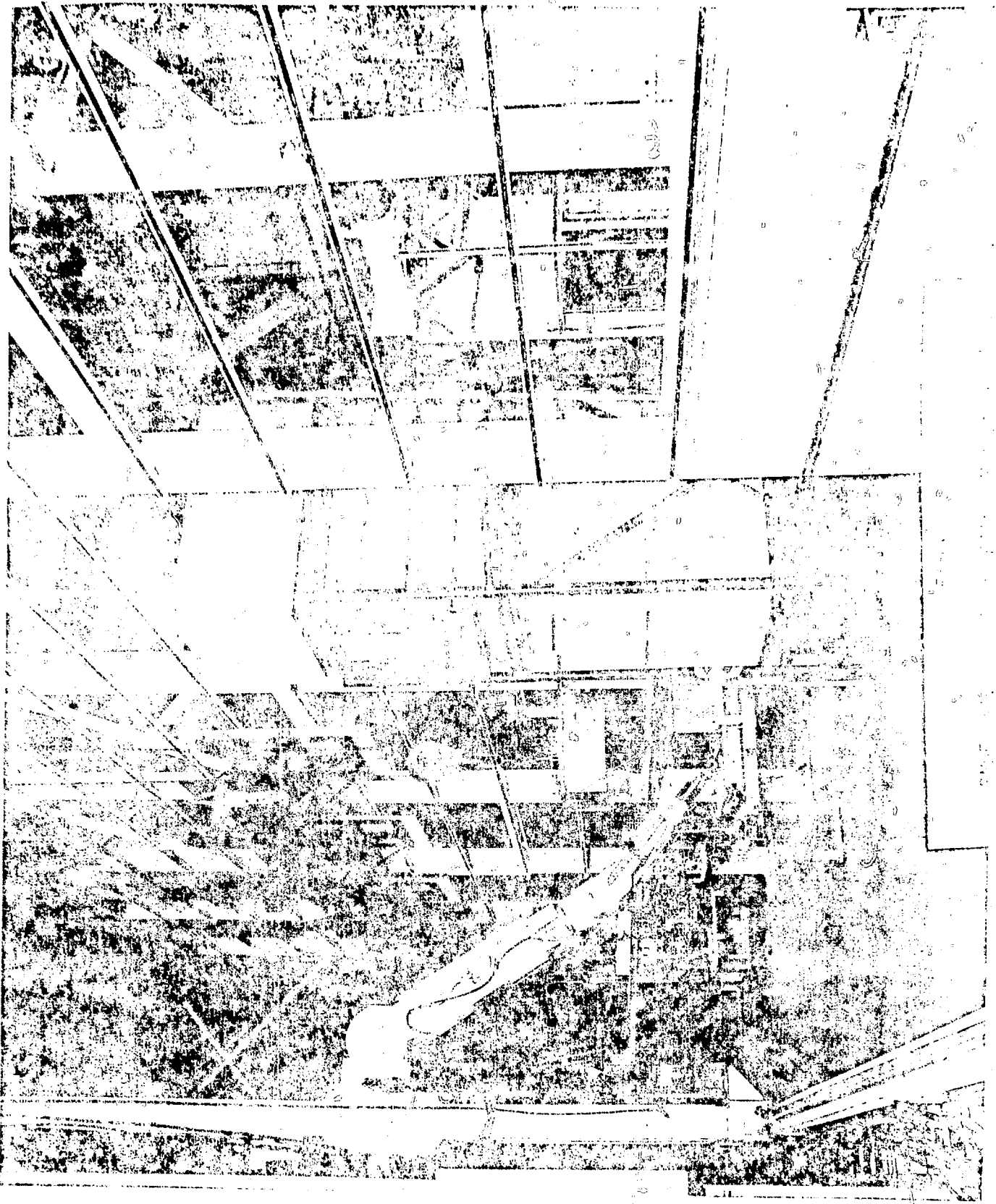
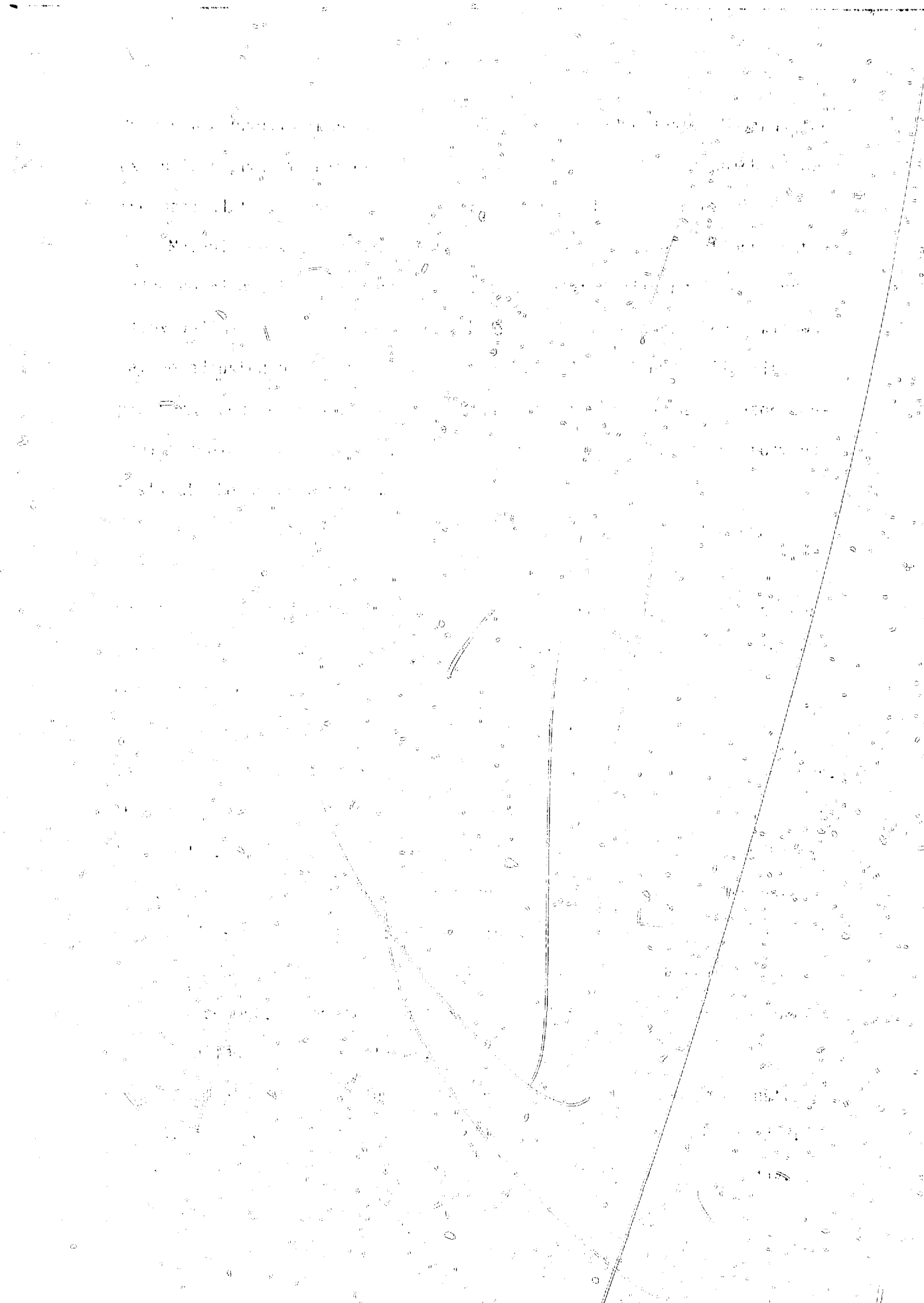


Figure 1  
RMIF Valve Corridor (Valve Mockup Section)





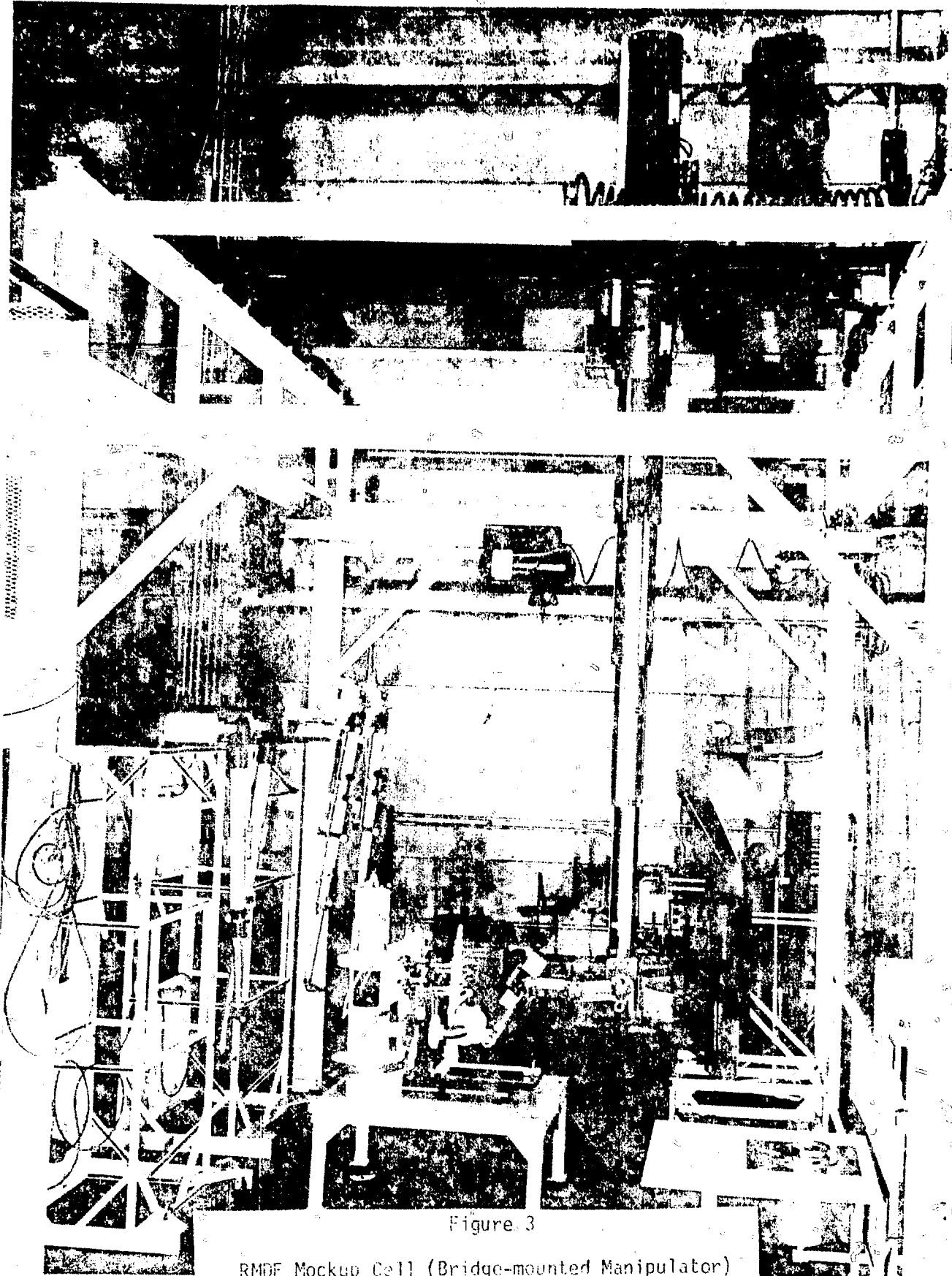


Figure 3

RMDF Mockup Cell (Bridge-mounted Manipulator)

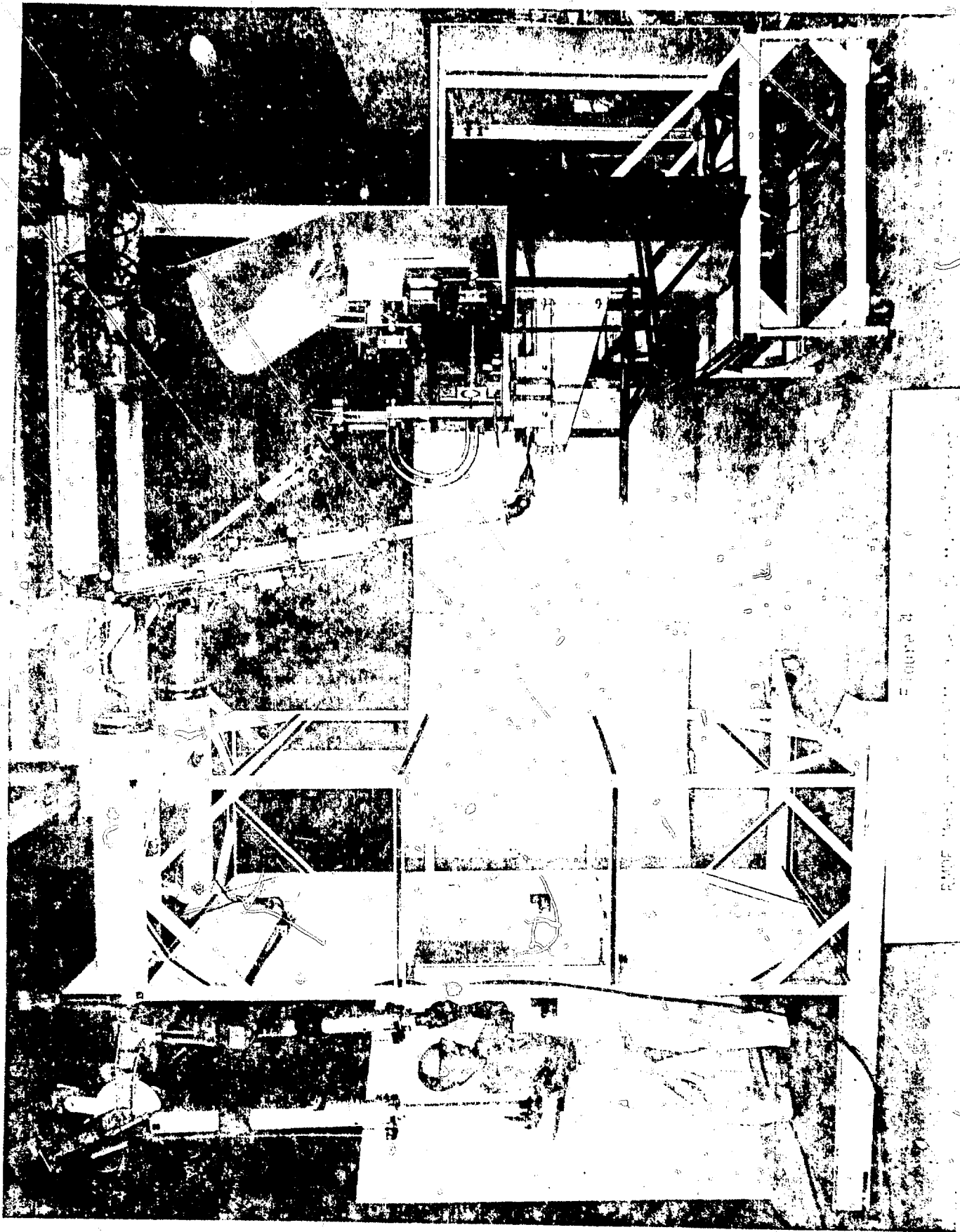


Figure 2

PLATE 1

These support frames are mounted on movable platforms which can be easily moved to a position that simulates a cell design. Two models of master-slave manipulators are available in the cell area for test and evaluation: a CRL-Model J which has a handling capacity of 9.1 kg (20 lb) and an extended-reach of 3.4 m (132 in.) and a CRL-Model F which has a handling capacity of 45.4 kg (100 lb) and an extended reach of 3.3 m (129 in.). These units provide the capability to perform checkout tasks involving either moderate or heavy-duty handling requirements.


The bridge-mounted, single-arm manipulator (PaR Model 3000) is an electromechanical manipulator with a 6.1 m (20 ft) telescoping tube, bridge, carriage and manipulator arm control unit. The manipulator has a vertical lift capacity of 453.6 kg (1000 lb). Design capacity of the arm is 68 kg (150 lb) with the hand and arm in any position. The control console for this manipulator may be located as required around the mockup cell by connecting the control console to one of several control boxes.

A bridge-mounted 907 kg (1 ton) hoist traverses the entire cell area and may be operated from a control unit which can also be located as needed around the cell area.

Television is used both as an auxiliary viewing system to help perform handling tasks in hard-to-see places and as a recording system to record remote handling techniques. As a recording system, the video tapes will be used for review and problem solving tasks as well as for demonstration and operator training aids. The TV system (Figure 5) consists of cameras with zoom and wide angle lens, pan and tilt control and monitors for each view. Both stereo and normal TV are available for



Figure 5  
TV and video camera



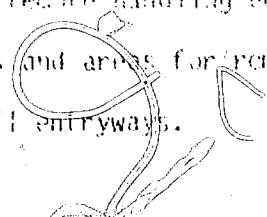
testing and evaluation. With these systems the capability is available for doing close alignment work as well as general surveillance and recording.

Mockup testing in the RMDF has not only provided NWCF design support, but will also provide the basis for developing operating procedures and plant checkout and startup test procedures. Handling procedures developed during mockup testing will be refined and issued as plant operating and maintenance manuals.

Another equally important use of the mockup facility is training of Operations and Maintenance personnel. In the RMDF, operators may become familiar with remote handling equipment, perfect handling techniques and train in full-scale plant situations in a radioactively cold environment. Following NWCF startup, abnormal plant conditions could be simulated and solutions to operating problems developed at the mockup facility without using costly production equipment and facilities. This capability will also support and increase the NWCF on-stream time.

#### CONCLUSION

During the three years of its existence, the RMDF has repeatedly proved its value in finalizing design concepts, proving equipment interface requirements, and developing new ideas and approaches to old problems. Specific contributions obtained from the facility include final sizing of the valve corridor and process cells, acceptance of recommended process system components, positioning of viewing windows, selection and sizing of remote handling equipment, development of maintenance methods, techniques and areas for remote equipment and input to design and location of cell entryways.



Along with detailed process system and facility models, remote mockup and testing is a tool that if used properly during the design phase of a project can provide information and data that can be obtained through no other means. In addition, equipment, materials and techniques developed for one project can be used on other projects to assist them in solving problems associated with remote methods. This is especially true of the RMDF. By its versatility and capability it has and is providing support to approximately five other INEL projects.

## FIGURES

1. RMDF Valve Corridor (Valve Mockup Section)
2. RMDF Valve Corridor (Filter Mockup Section)
3. RMDF Mockup Cell (Bridge-mounted Manipulator)
4. RMDF Mockup Cell (Master-slave Manipulators)
5. TV and Video Tape Units