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Water Immersion Facility

General Description

Spacecraft Design Division
Crew Station Branch

February 1978

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

WATER IMMERSION FACILITY

GENERAL DESCRIPTION

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February 1978

WATER IMMERSION FACILITY

GENERAL DESCRIPTION

REVISION BLOCK

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ILLUSTRATIONS

1.0 INTRODUCTION

The Water Immersion Facility (WIF) General Description, JSC 13808, provides information pertinent to the Water Immersion Facility. Information is based on the January 1978 WIF configuration. Located in Building 260.

1.1 APPLICABLE DOCUMENTS

a. Water Immersion General Facility Description, JSC-13808
b. Water Immersion Facility General Operating Procedures, JSC-13805
c. JSC Safety Manual, JSC-1700A
d. WIF Standard Operating Procedures, MSC-07652
e. WIF Training Plan, MSC-07682
f. WIF FMEA, Rev. A
g. Compressed Air For Breathing Purposes, BB-A-1034A

2.0 WATER IMMERSION FACILITY PURPOSE AND POLICY

2.1 PURPOSE. The Water Immersion Facility (WIF) provides an accurate, safe, neutral buoyancy simulation of zero gravity conditions for development of equipment and procedures, and the training of crews.

2.2 POLICY. The facility shall:

a. Maintain operational status at all times.

b. Insure maximum safety of all personnel by complying with all applicable safety regulations, approved pre-test checklists, and test procedures.

c. Extend maximum effort to maintain all schedules and target dates.

d. Provide maximum support for all training activities requiring the WIF.

e. Function in accordance with the WIF General Operating Procedures, Revision C.

3.0 DESCRIPTION

The WIF is a man rated simulator used to produce a weightless environment for flight crew training, procedures and equipment development, and engineering evaluation. The facility employs the theory of controlled buoyancy in water to simulate this environment. The WIF is a composite of various systems and subsystems that are necessary to provide accurate data and safe operations. The systems are:

a. Water Tank (Figures 1 and 2)
b. Television Monitors Console (Figure 3)
c. Environmental Control and Liquid Cooled Garment System (ECS/LCG) (Figures 4 and 5)
d. Ballast Systems (Figure 6)
e. Medical Support System (Figure 7)
f. Diving Equipment, Air Compressor and Storage (Figures 8, 9, 10 and 11)
g. Dressing and Teaching Facilities (Figures 12 and 13)
h. WIF Mockups, Shuttle Program (Figures 14, 15 and 16)
i. Typical Suited Test Operation (Figures 17, 18, 19, and 20)

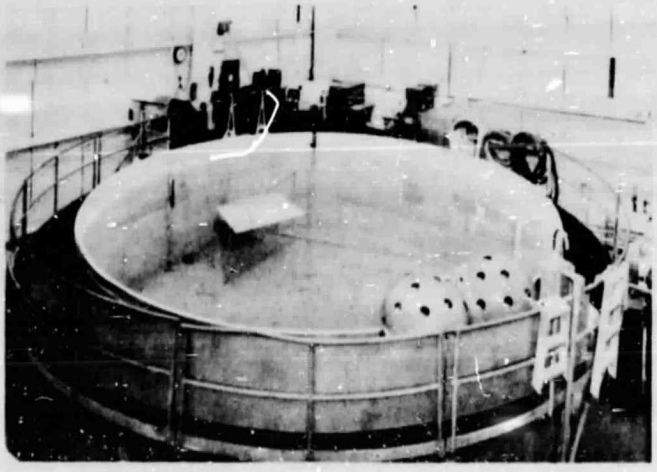

Figure 1.- Water Immersion Facility (WIF).

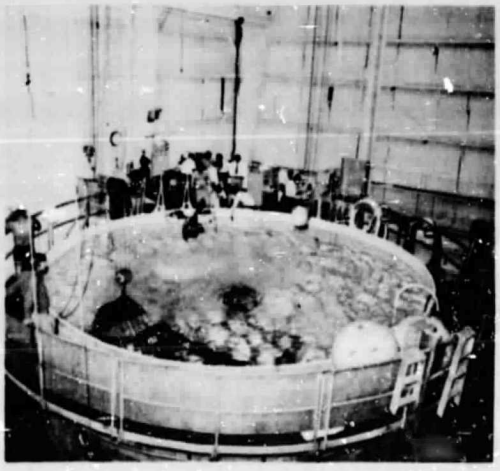

Figure 2.- Water Immersion Facility during test preparation.

Figure 3.- Television monitor's console.

Figure 4.- Environmental control and liquid cooled garment system console.

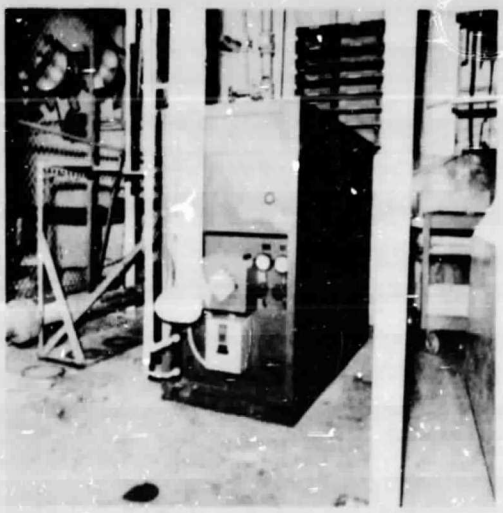

Figure 5.- Water Immersion Facility liquid cooled garment water chiller.

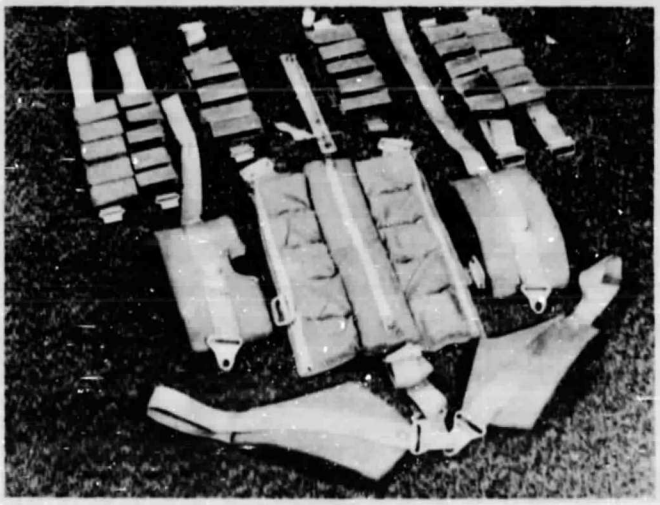

Figure 6.- Ballast weights.

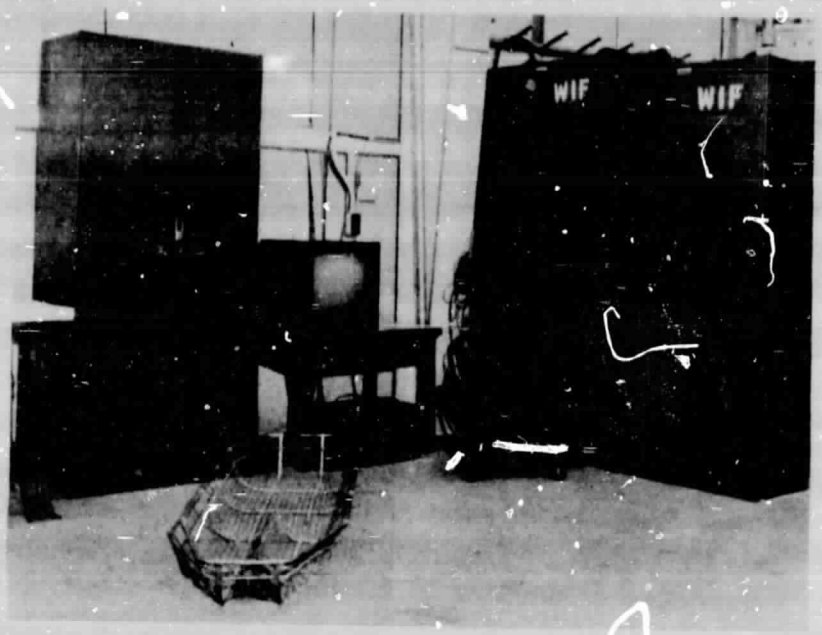

Figure 7.- Medical support system.

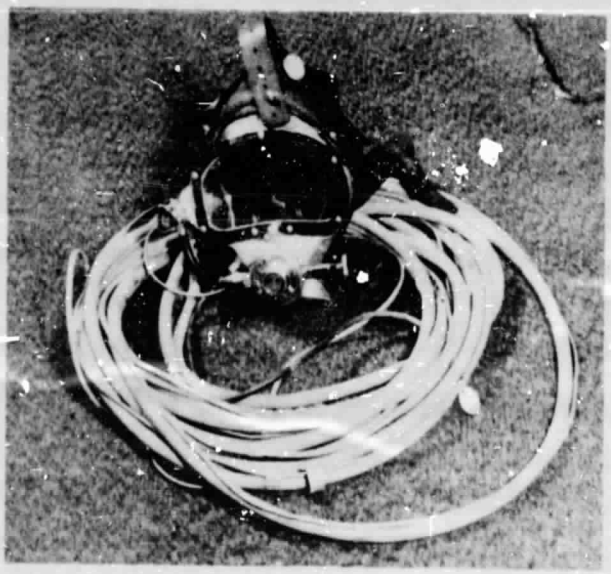

Figure 8.- Kirby-Morgan diving equipment.

Figure 9.- SCUBA diving equipment.

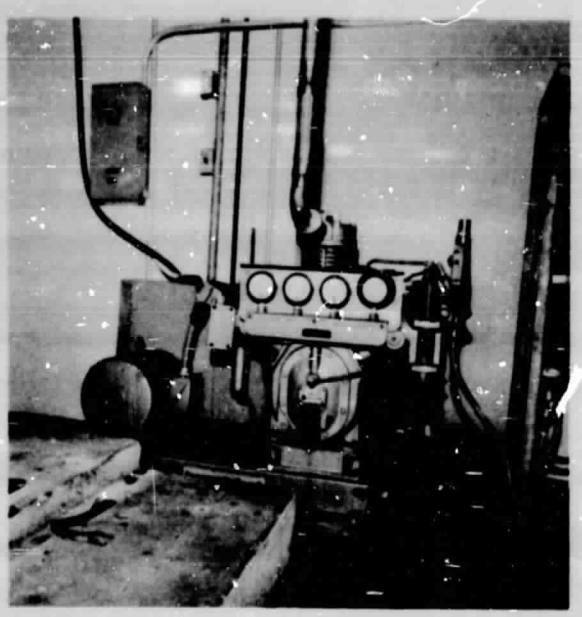

Figure 10.- Water Immersion Facility breathing air compressor.

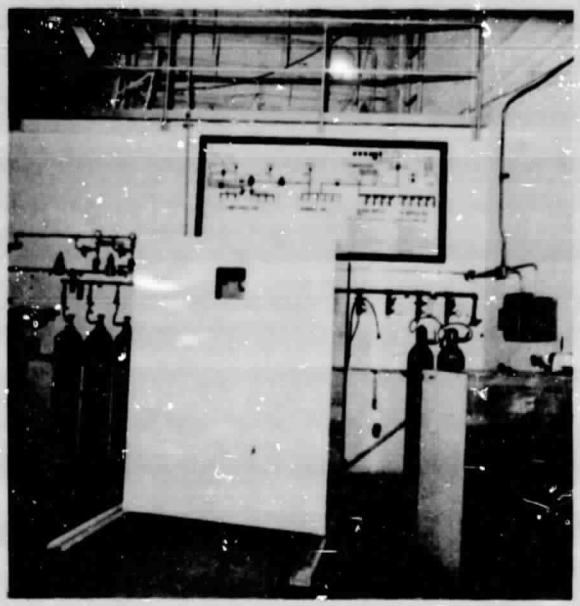

Figure 11.- Water Immersion facility breathing air fill station with protection shield in place.

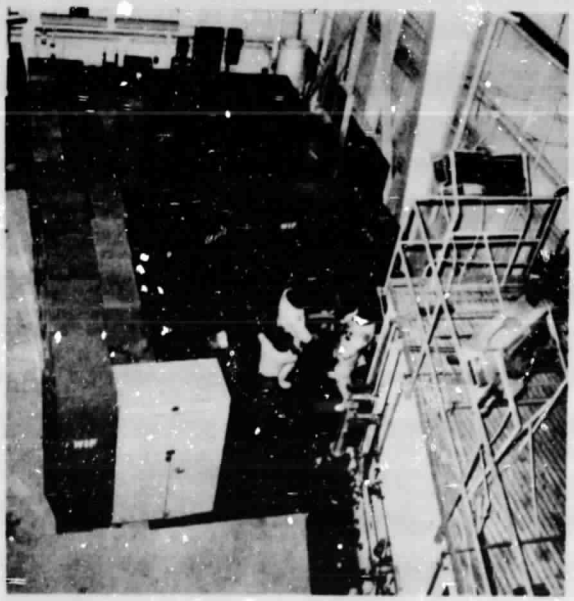

Figure 12.- Water Immersion Facility dressing area.

Figure 13.- Class room.

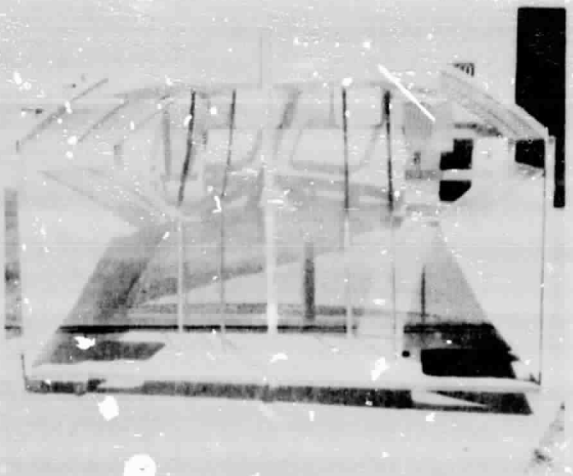

Figure 14.- Aft Orbiter flight deck mockup.

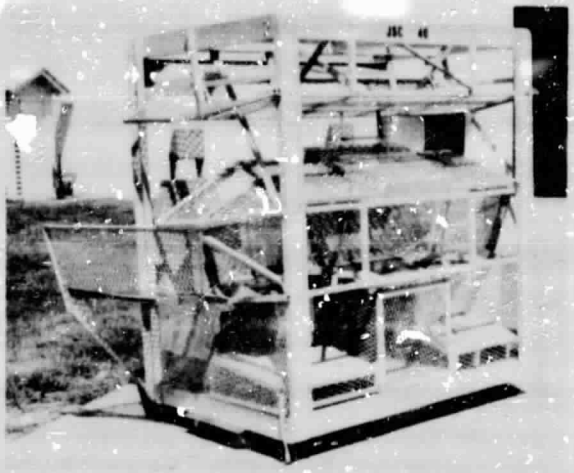

Figure 15.- Forward Orbiter flight deck mockup.

Figure 16.- Orbiter mid-deck mockup.

Figure 17.- Suited test subject.

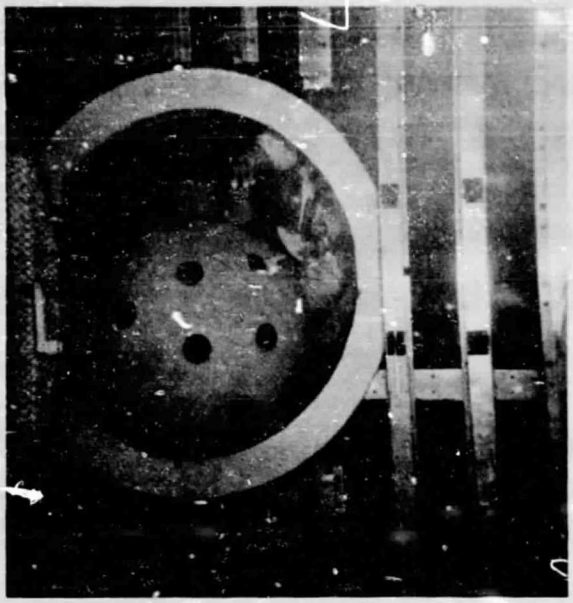

Figure 18.- Water Immersion Facility test subject evaluating mobility in Orbiter airlock mockup with personnel rescue enclosure.

Figure 19.- Suited test subject preparing to enter mockup.

Figure 20.- Water Imersion Facility test subject evaluating mobility in Orbiter airlock mockup.

3.1 WATER TANK AND SUPPORT EQUIPMENT. The water tank is located in the west end of the high bay section of Building 260. The tank is of metal construction and is 25 feet in diameter and 16 feet high. Near the top is a 2-1/2 foot wide work platform circumscribing the tank. On one quarter of the tank a work platform is extended to provide 275 square feet of space for facility test consoles.

Portholes are provided around the tank for underwater viewing. Underwater lights are available for television or movie camera illumination. Power for the lights and other instrumentation is provided in the tank area with the voltages of 28 Vdc, 115 Vac, 208 Vac, and 440 Vac 3 phase. Air is available for operation of pneumatic tools and an overhead crane. The overhead crane consists of an "H" shape bridge that can move the entire length of the building's high bay. The crane has lift heights of approximately 32 feet on all hoists including one 15,000 lb electric hoist, three 4,000 lb pneumatic hoists, and one manual hoist. All hoists are movable on the bridge. An additional air hoist is located on the backside of the instrumentation platform for placing equipment on the platform when the main crane is being used.

The water tank has standard filtering, chlorinating, and pumping systems. The water in the tank is temperature controlled with a heating capability to 135 $\pm$ 2° F.

3.2 COMMUNICATIONS SYSTEM. The WIF communications system provides two way communications between any combination of the test director, ECS console operator, medical monitor, test conductor, suit technician, television monitor, top side monitor, and all pressure suited crewmen.

One way communications from any of the named personnel to underwater support divers is made possible by underwater speakers. However, facility rules stipulate that only the test director will direct the underwater support divers.

The communication system is located in the test director's console, which is located on the WIF deck and has a prime and backup channel. The prime channel is used for normal operations. The backup channel is used as a backup mode in the event of prime mode failure. Communications to and from the suited crewmen is transmitted through an electrical cable in the life support umbilicals.

Should both prime and backup channels fail an emergency battery powered communications system is available. This system provides one way communications from the Test Director through an underwater speaker to the support divers.

3.3 ENVIRONMENTAL CONTROL AND LIQUID COOLED GARMENT SYSTEM (ECS/LCG). The ECS/LCG provides air and water for pressure-suited operations. This system is in the ECS/LCG console located on the WIF deck and controlled by the ECS/LCG console operator.

Breathing air and cooling water are carried to the suited crewmen through the life support umbilical.

The air system is capable of supplying breathing air at 10 scfm and at a total pressure of 10 psig. To prevent over pressurization, relief valves set at 11 psig are installed in the system. Suit operation pressure of 3.8 psig is set and maintained by adjusting the delta pressure valve, which is used as a suit exhaust fitting on the umbilical.

The LCG cooling water system, set at approximately 2 psig and 45° to 50° F, is capable of supplying water at 40 gallons per hour and is controlled by the ECS/LCG console operator.

Incorporated into the ECS is an alarm system. This system is composed of a series of pressure and flow switches that monitors suit air flow and pre-set pressure limits. The system is activated when suit air flow drops below 5 scfm and when suit pressure drops below 1 psig or rises above 5 psig and is located in the ECS/LCG console and on the Test Director's console. A backup air supply source composed of six K-bottles is incorporated into the ECS. This backup system is capable of supporting three suited crewmen for approximately 30 minutes at 10 scfm should the primary air source fail or drop below 85 psig. System activation lights a warning light on the ECS/LCG console.

The ECS/LCG and alarm systems are controlled and maintained by WIF personnel.

3.4 BALLAST SYSTEMS. Each system is composed of a front weight pack, a back weight pack, two wrist weight cuffs, and two ankle weight cuffs. The front and back weight packs are strapped together and each weigh approximately 45 pounds. There are pockets for weight addition and distribution.

Ballast systems provide weight for proper distribution to the pressure suited crewman. Neutral buoyancy is achieved for simulated weightlessness.

The system is constructed for front and back removal within 5 to 10 seconds.

The entire system is maintained by WIF personnel. Figure 21 shows a suited subject receiving ballast weights.

Figure 21.- Suit subject donning ballast system.

3.5 CLOSED CIRCUIT TELEVISION SYSTEM. The closed circuit television system is composed of one underwater hand held camera, one underwater pan and tilt camera, and two television monitors. There is the capability for site wide distribution.

The system is controlled and the responsibility of the center television support contractor. Control is from the television console located on the tank deck. The underwater hand held camera is carried by television support contractor divers, Figures 22 and 23.

To insure accurate training and safe operations this system must be operational for all pressure suited activities.

3.6 MEDICAL SUPPORT SYSTEM. The medical support system contains medical supplies and a resuscitator to aid the treatment of a victim of an accident. Hyperbaric chamber support is located in Building 32.

Direct support and maintenance is provided by qualified medical and chamber technicians from the Space and Life Sciences Directorate.

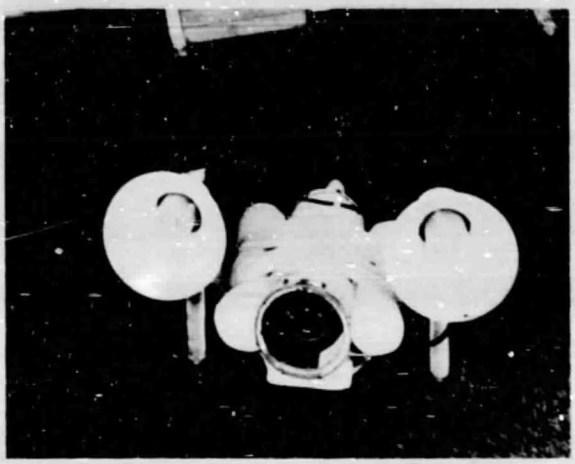

Figure 22.- Hand held television camera.

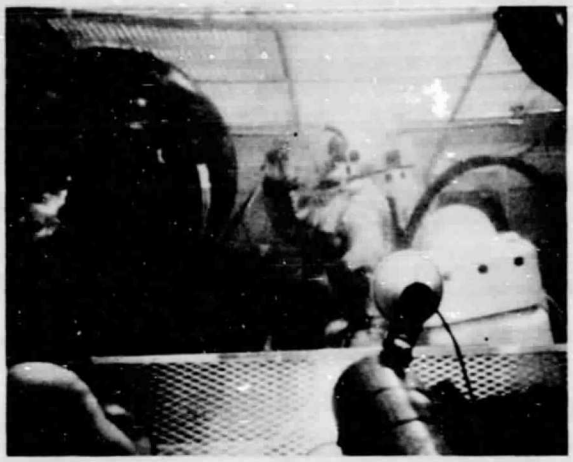

Figure 23.- Orbiter mid-deck neutral buoyancy testing.

3.7 DIVING EQUIPMENT AND AIR COMPRESSOR. The diving equipment is composed of SCUBA bottles with J-valves, safety bottles with J-valves, SCUBA regulators, safety regulators, snorkels, diving masks, swim fins, weight belts, and Kirby-Morgan and Aquadyne diving helmets. Normally, one set of fins, mask, weight belt, and snorkel is assigned to each support diver with SCUBA bottles and regulators stored in racks located in Building 260. Individually assigned equipment is kept in lockers. Each WIF support diver is thoroughly trained in the use of this equipment.

The Kirby-Morgan and Aquadyne diving helmets are full face diving masks used by WIF divers when assembling trainers in the water. The helmets are used by test subjects during shirtsleeve test modes. And, the helmets are also used because they contain two way communications to the surface and an air source via an umbilical, which gives the user an extended diving time. The equipment is maintained by WIF personnel.

The Model 10T2, Type 30, air compressor is located on the ground floor. The compressor is used for filling SCUBA bottles, safety bottles and the K-bottles used for the ECS backup air source and provides the primary air supply to the ECS/LCG console. The compressor is used to provide breathing air for other center users. Detailed operational instructions for running the compressor are in chart form on the wall above the fill station. Air quality specifications are given in Specifications for Breathing Air BB-A-1034A.

A filter for carbon monoxide and a high temperature alarm is included in the breathing air compressor system. When temperature is too high, an alarm system will be activated, which is a warning light and buzzer. Carbon monoxide content is measured by a Del-Monox visual

color check. Figures 24 and 25 show the warning light and buzzer and the carbon monoxide filter.

Maintenance of the compressor is performed by the center maintenance contractor.

3.8 DRESSING FACILITIES. Dressing and suit up areas for WIF activities are located in Building 260. This facility contains clothes lockers, shower, lavatory, and toilet.

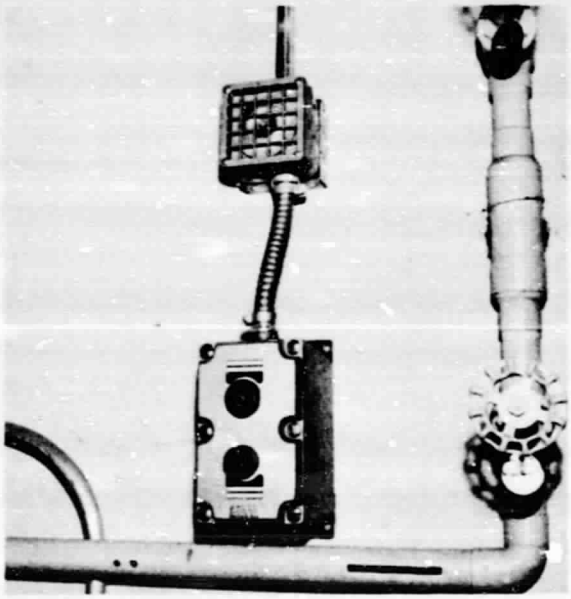

Figure 24.- Water Immersion Facility breathing air compressor high temperature alarm.

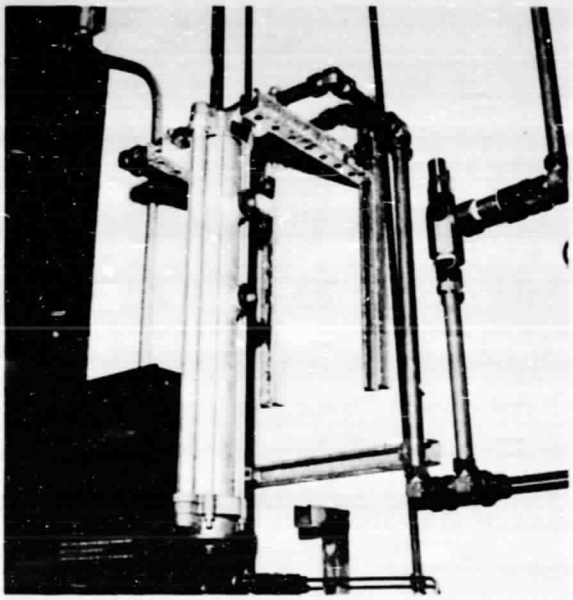

Figure 25.- Water Immersion Facility breathing air carbon monoxide filter.