

UNCLASSIFIED

AD NUMBER
AD440341
NEW LIMITATION CHANGE
TO Approved for public release, distribution unlimited
FROM Distribution authorized to U.S. Gov't. agencies only; Administrative/Operational Use; APR 1964. Other requests shall be referred to Naval Civil Engineering Laboratory, Port Hueneme, CA.
AUTHORITY
USNCBC ltr, 24 Oct 1974

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

AD 4 4 0 3 4 1

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

440341
BY DDC

FOR OFFICIAL USE ONLY

Task Y-F011-05-03-401(g)

Type β

DDC AVAILABILITY NOTICE

U. S. Government agencies may obtain copies
of this report from the U. S. GPO. Other
qualified users shall request through

*Chief,
Bureau of Yards & Docks
Department of the Navy
Washington 25, D.C.
Attn: Code 71A*

Technical Note N- 588

TEST PROCEDURES FOR PROTECTIVE SHELTERS

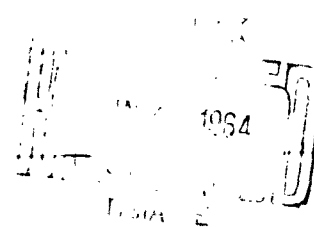
30 April 1964

by

W. R. Nehlsen

U. S. NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

440341



TEST PROCEDURES FOR PROTECTIVE SHELTERS

Task Y-F011-05-03-401(g)

Type C

by

W. R. Nehlsen

ABSTRACT

Protective shelters must be maintained in good condition to function properly when required. This report lists equipment that should be checked annually or more often to ensure that shelters can operate as designed.

Procedures for testing some special items of shelter equipment are also given. Development of additional methods for test inspections are recommended for establishment of an improved standard operational readiness inspection.

I. INTRODUCTION

Protective shelters and facilities may be needed on a very brief notice and routine periodic inspections of operational readiness are necessary to insure proper function at the time of need. Items intended for an annual general inspection are given in the check list in sections III through XI. Items requiring more frequent inspections appear on the check list with a notation of recommended inspection intervals.

Shelters and facilities that are in routine use will require in each case, preparation of an individual inspection and maintenance procedure, combining this check list with the schedule of routine preventive maintenance services.

The check list specifies the items and functions to be inspected. Additional information on testing methods is included when inspection requires special methods that may not be familiar to base Public Works personnel. The Appendix lists test equipment needed for normal checking procedures. All items on these lists will not necessarily apply to every shelter to be inspected. Reference to NAVDOCKS P-81¹ will assist inspection personnel in identifying various components.

A list of personnel that usually are available in civilian or military occupations at shore stations, who can provide assistance in making one or more of the suggested checks is also included.

Section XII discusses the development of procedures and equipment for use in a standard inspection procedure.

II. INSPECTION DOCUMENTS

Wherever possible, the design specifications and construction drawings of the structure should be obtained prior to inspection. These will show utility connections, the location of underground pipes and tanks near the shelter, and may indicate the intended functional parameters of the shelter equipment. Maintenance schedules, if used, will also yield valuable information on the condition of the shelter. References 2 through 7 will assist in making a thorough inspection.

III. OUTSIDE INSPECTION

The outside inspection covers:

A. Earth Cover

1. Erosion
2. Settling
3. Drainage channels

B. Fill Pipes for Storage Tanks

1. Locks in place and in good condition
2. Keys available
3. Plainly marked as to contents in tank
4. No adverse corrosion

C. Utilities Connections and Condition

1. Power lines
2. Water
3. Sewer
4. Telephone
5. Fire alarm

D. Antennas

1. Guy wires and turnbuckles
2. Feedline
3. Standing waves on feedline

E. Vents and Blast Closure Outside Openings

1. Corrosion
2. Obstructions-windblown debris-bird nests

F. Escape Hatches

1. Corrosion
2. Obstructions

G. Entrance Passage

1. Cleanliness
2. Drainage

IV. INTERIOR STRUCTURE

The interior structure inspection covers:

A. Blast Doors

1. Swing free
2. Corrosion
3. Latch tight

B. Interior of Structural Shell

1. Water tightness
2. Corrosion
3. Cracks
4. Sagging
5. Bolt tightness

C. Floor

1. Drains
2. Cracks
3. Cleanliness
4. Signs of rodents or other pests (check monthly)

D. Equipment Shock Mounts

1. Adjustment
2. Condition of rubber
3. Dashpots - fluid leaks
4. Corrosion
5. Lubrication

E. Air Locks

1. Clothes chute
2. Membrane door

F. Lighting

1. Switches
2. Bulbs or tubes

V. ELECTRIC POWER SYSTEM

The electric power system inspection includes:

A. General

1. Switches and breakers (corrosion, dirt, etc.)
2. Connections
3. Insulation

B. Emergency Generator

1. Fuel storage - drain, flush, and refill. If gasoline, do on 6 months interval
2. Fuel lines - fittings
3. Batteries
4. Engine - do normal annual preventive maintenance schedule recommended by manufacturer
5. Switches and starting
6. Start and operate for at least 1/2 hour (recommended every 30 days)
7. Output (after all shelter equipment is checked and running, check voltage and amperage)

VI. AIR SUPPLY SYSTEMS

The air supply system inspection includes:

A. Blast Closure Valves

1. OCDM Type, Army Chemical Corps M1 and other blast-actuated mechanical types. (See NAVDOCKS P-81, p 85-91.) These valves contain a spring loaded valve disc and stem. Proper operation depends on freedom of movement of disc and stem, a smooth seating surface, and good condition of spring. Disc should close with light finger pressure. Partial disassembly of valve and connections will usually be necessary to inspect internal parts for corrosion and condition of sealing gaskets.
2. AMF Blast Closure with light flash activated closure mechanisms. (References 6 and 7 contain additional information on light flash activation circuits.)

a. These closures use a small explosive valve triggered by an electric circuit activated by a double light flash. The flash detector is located outside the shelter. The explosive valve and a high pressure air bottle are located in a control box inside the shelter. When triggered, the explosive valve admits pressurized air to a cylinder on the main closure shaft and the air pressure slams the closure shut. Each use requires replacement of the explosive valve. Extreme care is necessary in checking these closures.

b. First step in checking is to disconnect wires to explosive valve (see Figure 1) and put the 4-way valve in the control box to a position where no pressure can be transmitted to the valve. Then, inspect all parts of valve for corrosion and proper lubrication.

c. Air bottle pressure should be 1200 psi.

d. Check air system by opening by-pass shut-off valve and turning 4-way valve to position to close the main valve head. Be sure all personnel are clear of main valve head when this test is made.

e. Rotate 4-way valve to reopen position. Main valve head should reopen.

f. Close by-pass valve. Air bottle should be refilled to 1200 psi.

g. To check light detector condition without discharging the explosive valve, the wires into this valve should be left disconnected and an ammeter connected across the loose wires. When the light detector is activated, this meter should show 1 to 3 amps. To activate the light detector, two lights are required; one capable of emitting a high intensity flash of light and the other, a 250-watt heat lamp. A high intensity electronic type photoflash unit may serve for the flash source. These two light sources should be mounted about 12 inches from the detector and arranged so that both can be operated simultaneously. This will provide the double light impulse required since the photoflash discharge will be completed before the heat lamp filament has reached full brightness.

The double light impulse is characteristic of atomic explosions. It may be necessary to move the photoflash unit even closer than one foot. It also may be necessary to switch on the heat lamp a fraction of a second before the photoflash so that the heat lamp filament is not too long delayed in reaching maximum brightness.

h. Reconnect wires, check air bottle pressure and 4-way valve position after all faults have been corrected.

B. Collective Protector

1. Prefilter

- a. Replace if dirty
- b. Check gaskets

2. Flexible ducting

- a. Cracks and deterioration
- b. Fastening

3. Control damper

- a. Lubrication
- b. Corrosion

4. Blower and motor or engine drive

- a. Lubrication
- b. Engine maintenance (exercise monthly)
- c. Fastenings

5. Particulate and charcoal filters (preoperating check)

- a. Visual inspection for cracks, sagging or deterioration (check as possible without disassembling unit)
- b. Gasket condition

6. Air flow and pressurization

a. Air flow through filters. The filter and blower system must be checked for proper volumes and pressures. If a U-tube water manometer with about 6-inches of capacity and several pressure taps are not installed on the filter and blower system, a permanent installation of these should be made prior to checking the blower-filter unit. Figure 2 shows the general requirements for this installation. Before checking further, install new prefilters if they are dirty. Also, open at least one set of air lock and outside doors. With blower operating, the pressure differential from inlet plenum to outlet plenum should be 2.2 to 2.5 inches for the M9A1 unit (see reference 5) and 3.0 to 3.5 inches for the M10A1 unit. If other filter units are in use, design data must be obtained for these. Adjust the flow damper to obtain the proper pressure drop across the filters, then check the air flow cfm rate. If the proper pressure drop cannot be obtained by opening or closing the damper, the check of the air flow cfm rate will give an indication of the source of trouble. However, the air flow cfm check should be made even if a normal pressure drop has been obtained across the filter unit.

To check the air flow cfm rate, an anemometer or pitot tube, as listed in the test equipment list at the end of the report, can be used. The pitot tube is most advantageous if a straight run of metal-ducting is available near the collective protector discharge. The anemometer is best used where all the air to the shelter is being discharged at a few openings that are readily accessible.

To use the pitot tube, cut a small hole near the downstream end of the straight duct, preferably about 7 diameters downstream from the last elbow before the straight run. Close the hole around the pitot tube with a cardboard shield. Read the pressure reading on a draft gage connected across the side arm and end of the pitot tube. The pitot tube must point directly upstream when the reading is taken. A carpenter's square is useful in keeping the tube perpendicular. The highest reading will be obtained when the tube is properly positioned. The average duct velocity, in feet per minute, is then computed by the formula 3250 times the square root of the draft gage reading in inches of water. Readings should be

taken preferably when the air temperature is between 60 and 80 F. The total air flow in cfm is the average velocity times the cross-sectional area of the duct in square feet. The duct velocity will usually be about 800 fpm.

To determine flow with the anemometer, it is necessary to use it to measure air velocity in feet per minute at each discharge opening in the ventilation system. For this purpose, remove any distributing grills, take several readings at each opening and then calculate the average velocity for that opening. Measure the size of the opening and calculate the cross-sectioned area in square feet. The fpm velocity times the square feet of discharge area gives the cfm for that opening. The sum of cfm for all openings gives the total filtered air output. This should total the design capacity.

If the air flow determined by the anemometer or pitot tube is lower than the design capacity, open the damper further and recheck. If proper flow cannot be obtained with the damper wide open and with the pressure drop across the filters of about 4.5 inches, a new particulate filter section is needed. If excessive air flow is found to occur at the design pressure drop for the filter unit, the particulate or gas filter may be loose or damaged. The pressure drop across the particulate filter generally will be at least 1.0 inch. The gas filter pressure drop should be at least 1.25 inches.

b. Pressurization. If a built-in manometer and pressure taps are not provided for the shelter and air locks, they should be installed before checking shelter pressurization. Figure 3 shows a typical arrangement. Copper tubes should be installed to run to the points indicated. The number of valves and length of tubing required for a particular installation depends on the number of rooms to be tested. The tube going to the outside from valve 1 should be terminated at a point completely sheltered from the wind. Before making pressurization tests, set the manometer at "zero" point and close valves 3 through 6. Also close shelter doors and adjust air lock flow regulators to approximate operating positions.

Start the collective protector system blower and set damper to give the proper filter pressure drop established in paragraph a. above. First, check the shelter pressure by opening valve 3. (Note, valves 1 and 2 are

always kept open.) The pressure should be 0.5 to 0.6 inches of water. If a relatively higher or lower reading is obtained, adjust the air lock exhaust regulators and anti-backdraft valves and any additional regulators that may be provided. After the shelter has been adjusted to the proper pressure level, close valve 3 and check the pressure in the shower room by opening valve 4. This pressure should be between 0.20 to 0.45 inches of water gage. Next, in similar manner, check the pressures in the outer and inner air locks with valves 5 and 6. Pressure in the inner air lock should be between 0.30 to 0.50 inches and between 0.40 to 0.55 inches for the outer air lock. If more than one air lock system is provided, openings should be adjusted so that about the same amount of air is going out each system.

If it proves to be impossible to obtain a high enough pressure in the main shelter even with regulators almost closed, it is likely that leaks or improper openings exist in the shelter. Check for open cracks, drains, vents, conduits, antenna ports, and unauthorized changes in the shelter structure. Caulk, tape, or board over any such openings and recheck for proper pressure levels with the filtered air supply being delivered at proper rate and pressure.

7. Filter efficiency

It is generally impractical to test the efficiency of the particulate filters without special equipment and trained personnel. However, some stations with extensive industrial hygiene facilities may be able to make a field check for leakage. If millipore filter air sampling units are available, a check can be made with a methylene blue aerosol. Equipment required includes two millipore filter air samplers, a laboratory microscope with oil immersion lens, a vacuum pump, and a small paint sprayer. The air samplers with 0.4 or 0.8 micron pore size millipore filters should be connected to the manometer taps to draw air from upstream and downstream of the filter unit. About a pint of 2 percent solution of methylene blue in water is put into the paint sprayer and the sprayer adjusted to produce a very fine mist. This mist should be discharged for about 10 minutes near the ventilation air inlet while the blower and both air samplers are running. A small piece of each millipore filter is then placed on a microscope slide and rendered transparent with immersion oil. Each piece is observed for very small particles at about

900 magnification. There should be very few of the blue particles on the downstream sample and a large number on the upstream sample. The ratio of number of particles should be higher than 5000 to 1. If it is not, a special check should be requested.

8. Emergency air control systems

- a. Oxygen bottle weight
- b. Oxygen bottle regulator
- c. Hand blower operation
- d. CO₂ canister weight and condition
- e. O₂-CO₂ test kit - renew chemicals

C. Air Cooling (Check and run monthly unless only well water is being used. An air conditioning mechanic should do this work.)

- 1. Compressor
- 2. Expansion valve and controls
- 3. Condenser air or water flow
- 4. Cooling coil
- 5. Cooling water, piping, valves, drain or pump
- 6. Cooling water storage
- 7. Ice unit
- 8. Flexible connections
- 9. Leakage and corrosion

D. G-Alarm

- 1. Check according to manual
- 2. Collective protection by-pass automatic operation

VII. WATER SUPPLY

The water supply system inspection includes:

A. Storage Tanks

- 1. Bacteriological and taste test
- 2. Drain, flush, and refill (6 months)
- 3. Valves and lines
- 4. Hand pump
- 5. Flexible connections

B. Well and Pumps

1. Water table
2. Capacity (run at design capacity for 1 hour)
3. Control system and switches
4. Valve operation

C. Decontamination Showers

1. Water heater
2. Shower valves and drains
3. Hand pumps

VIII. SANITARY SYSTEMS

The sanitary system inspection covers:

A. Trash Collection Containers

B. Sewage Disposal

1. Toilets
2. Chemicals or bags
3. Drain or check valves
4. Cleanliness and maintenance
5. Sumps and floats
6. Pumps
7. Vent system
8. Flexible connections

IX. COMMUNICATIONS

The communication system inspection covers:

A. Telephones

1. Circuits
2. Switches

B. Radio

1. Antennas and connections
2. Corrosion
3. Battery replacement (yearly or oftener)
4. Operate on all bands

C. Interior PA System

1. Batteries
2. Operate for one-quarter hour or more from line power supply

D. R.I. Shielding

1. Continuity
2. Corrosion
3. Ground

X. SPECIAL SUPPLIES

The special supplies to be inspected include:

A. Decontamination

1. Gas masks
2. CW test kit
3. Decontamination chemicals
 - a. Bleach
 - b. Formaldehyde
 - c. DANC
4. Ropes and signs
5. Clothing, gloves and booties

B. Radiation Monitoring

1. Remote detectors (replace batteries)
2. Personnel monitor (replace batteries)
3. Dosimeters

C. Internal Fire Protection

1. Water extinguisher
2. Sand buckets
3. CO₂ bottle weights

D. Operation Instructions

1. Detailed shelter organization instructions should be stored in the shelter.
2. Detailed mechanical operation manual for all equipment.

E. Emergency Tools

1. Shovels
2. Sledge
3. Pick
4. Axe
5. Tool kits for engine-generator and other mechanical equipment
6. Weapons
7. Epoxy patching kit
8. Lanterns
9. Rope

XI. SUBSISTENCE SUPPLIES

The subsistence supplies to be inspected include:

A. Food

1. Quantity
2. Condition
3. Dishes

B. Medical and First Aid Supplies

C. Blankets and Towels

XII. DEVELOPMENT OF STANDARD TEST PROCEDURES

The problem of checking and maintaining the operation readiness of protective shelters and facilities is a considerable one, particularly in shelters complicated with equipment for resisting higher blast levels and for extended stay times. If the facility is in continuous use as a protective shelter, the problems are somewhat different than if a standby status is being maintained. Dual-use shelters may be susceptible to loss of protective capabilities by inadvertent changes. Standby facilities are more prone to deterioration by lack of use of equipment.

The first necessity in establishing an effective standard inspection procedure is the development of a body of data on experience with existing shelters. The best way to do this would appear to be to distribute the check list developed in this report to all activities having existing protective facilities requiring periodic inspections, and to request submission of a report on inspection and current preventive maintenance procedures in use for the shelters. The results should indicate most shelter deficiencies and give some correlation between preventive

maintenance procedures and operational readiness of shelters. This data would then serve as a basis for improved check lists and preventive maintenance. Local Public Works personnel would also begin to gain greater familiarity and interest in operations of protective shelters.

There are several items of equipment to be checked that will require development of simplified procedures and equipment to permit operational inspections by Public Works staffs. Standardized procedures need to be developed and tested for use in checking:

a. CBR Protection Devices

1. Alarm system
2. Particulate filter
3. Gas sorber
4. Air flow control

b. Pressurization and Leakage

c. Blast Closure Activation Devices

Of these requirements, item a. is already under development under Task Y-F011-08-03-301. Item b. might well be included in the same standard procedures and is particularly necessary in checking shelters developed from slanted construction.

XIII. RECOMMENDATIONS

1. The check list developed should be put in use as extensively as possible, with a future revision planned as experience on its use accumulates.
2. The CBR test kit being developed should include methods for testing pressurization and leakage.
3. A test method should be developed for light flash detectors.

REFERENCES

1. Bureau of Yards and Docks. NAVDOCKS P-81, Personnel Shelters and Protective Construction. Washington, D. C., September 1961.
2. U. S. Army, Corps of Engineers. Manual EM1110-345-461, Collective Protection Against Chemical, Biological, and Radiological Warfare Agents. Washington, D. C., 1 October 1958.
3. U. S. Army Chemical Corps Engineering Command. ENCR No. 30, Protection of Structures from Chemical, Biological, and Radiological Contamination. Army Chemical Center, Maryland, June 1959.
4. Department of Defense. Protective Construction Review Guide, Volume I. Office of the Assistant Secretary of Defense (Installation and Logistics). Washington, D. C., June 1961.
5. Bureau of Yards and Docks. NAVDOCKS P-92, Gas-Particulate Filter Units M9A1 and M10A1. Washington, D. C., May 1962.
6. Francy, LCDR W. J., "A New Blast Closure Device for Personnel Protective Shelters," Technical Digest, Volume 100 (October-November 1959), pp 3-7, Bureau of Yards and Docks, Washington, D. C.
7. Champeny, J. C., et al. "Nuclear Bomb Alarm Systems," Electronics, 8 May 1959.
8. Department of the Army, Signal Corps. Instruction Manual, Radiation Detection and Alarm System, AN/FJW-1(V), 22 November 1958.

APPENDIX

TEST EQUIPMENT LIST

1. A-C clamp ammeter (Weston, Amprobe)
2. General purpose electrical testor
3. Fuel pump for pumping fuel storage
4. Water pump for pumping water storage
5. Air conditioning mechanic's tool kit
6. Electrician's tool kit
7. Engine mechanic's tool kit
8. Instrument technician's tool kit
9. Draft gage manometer - 0-6 inches (Ellison, Meriam or similar brand)
10. Rubber tubing
11. Sampling taps
12. Anemometer (Biram type) - 4 inch diameter - with jeweled bearings
13. Electronic photoflash unit
14. Pitot tube (Ellison)

SUGGESTED TEST PERSONNEL

1. Mechanical engineer
2. Instrument technician
3. Air conditioning mechanic
4. Diesel-electric mechanic
5. Civil engineer
6. Utilities foreman

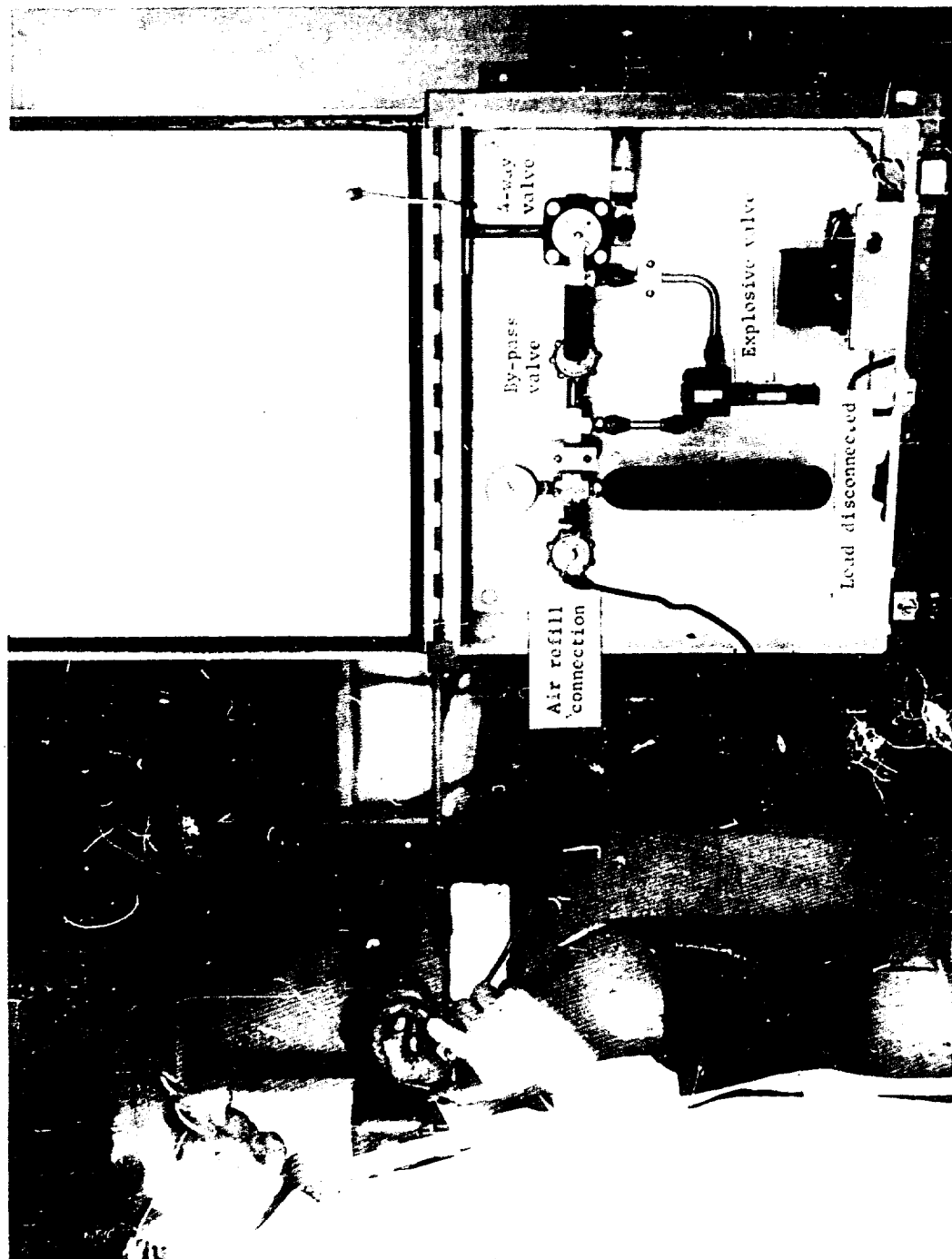


Figure 1. AMF blast closure control panel.

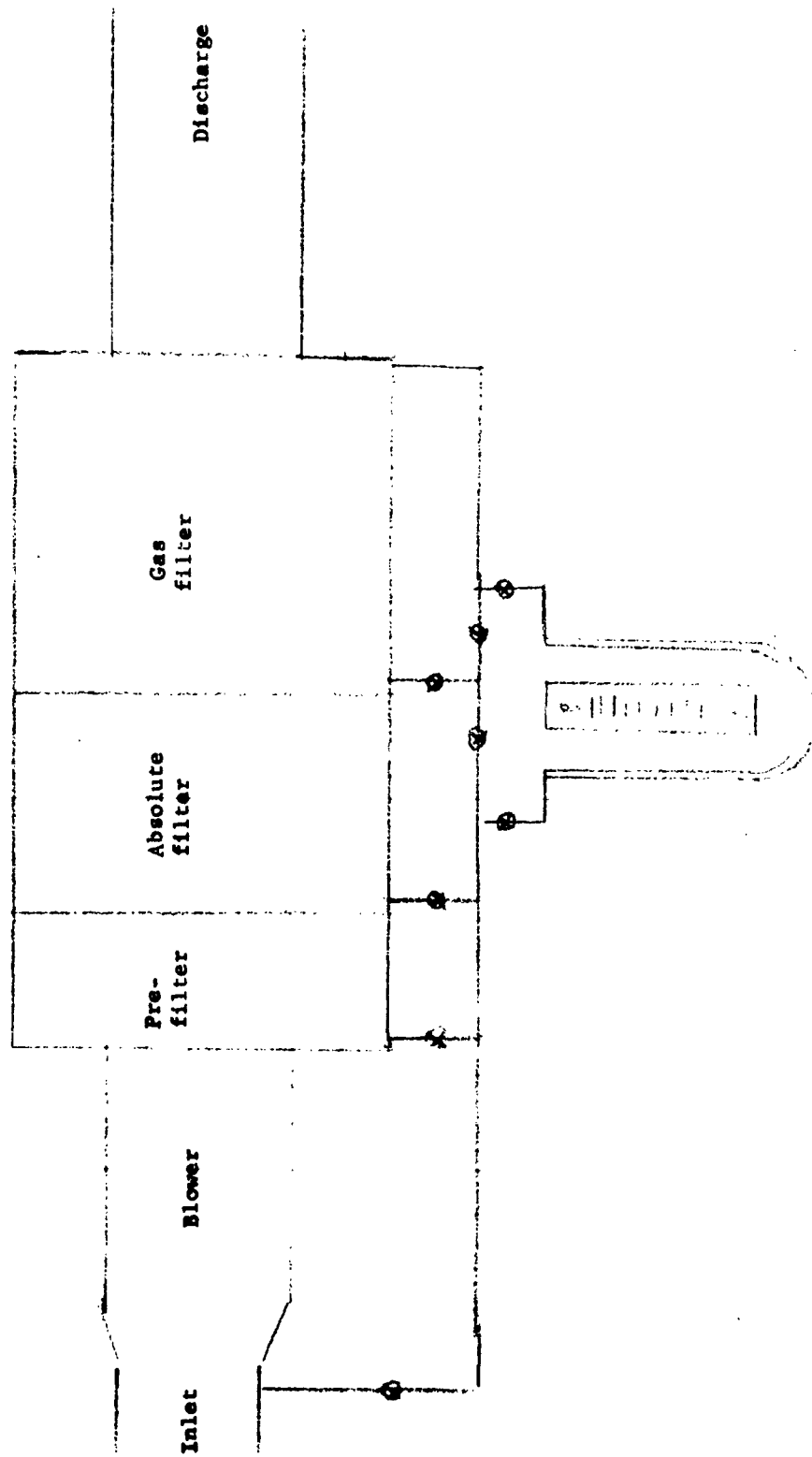


Figure 2. Manometer installation for filter system.

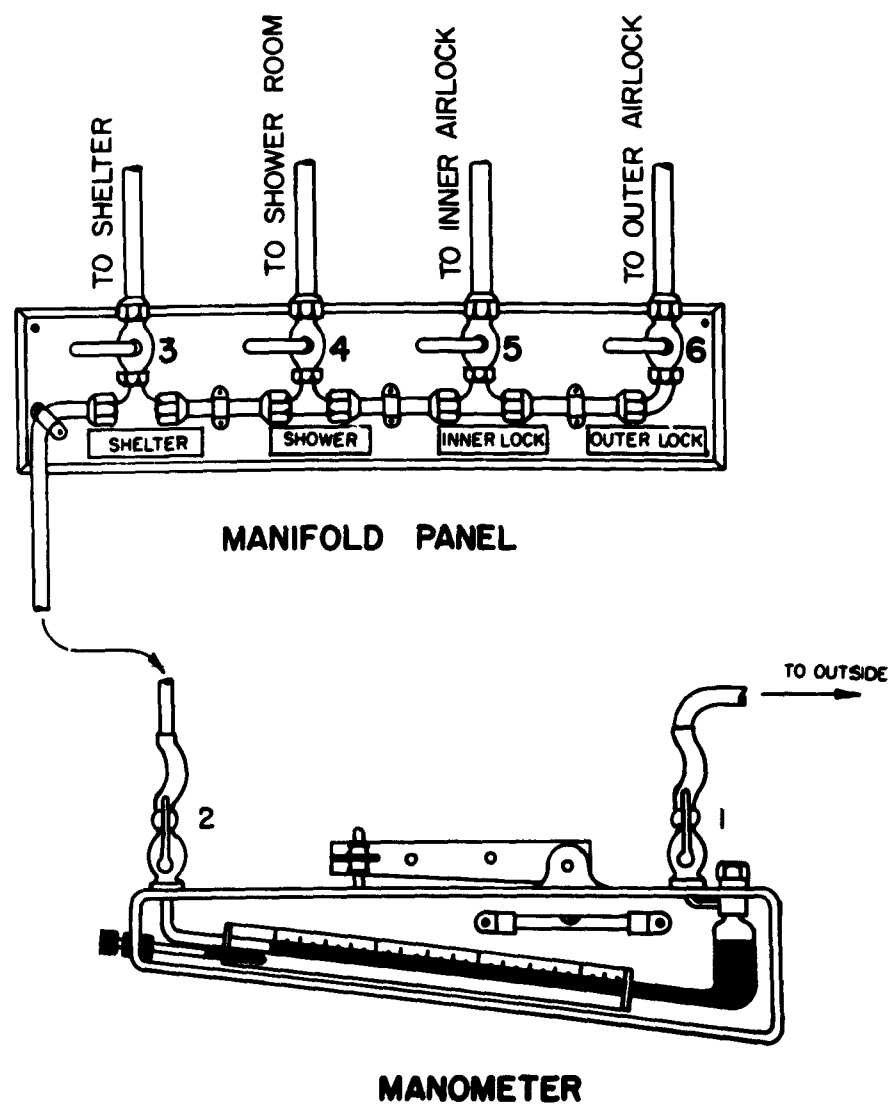


Figure 3. Manometer and manifold arrangement for shelter pressure tests.