

UFC 4-229-01N
16 January 2004

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: GENERAL MAINTENANCE FACILITIES



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DESIGN: GENERAL MAINTENANCE FACILITIES

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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEERING SUPPORT AGENCY

Record of Changes (changes indicated by \1\ ... /1/)

<u>Change No.</u>	<u>Date</u>	<u>Location</u>

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FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with [USD\(AT&L\) Memorandum](#) dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request \(CCR\)](#). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site <http://dod.wbdg.org/>.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

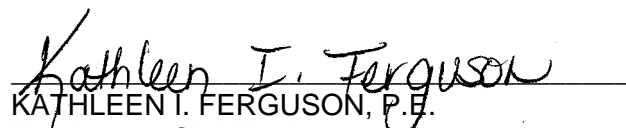
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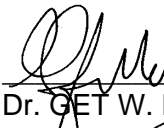
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CHAPTER 1

INTRODUCTION

1-1 **PURPOSE AND SCOPE.** This UFC is comprised of two sections. Chapter 1 introduces this UFC and provides a listing of references to other Tri-Service documents closely related to the subject. Appendix A contains the full text copy of the previously released Design Manual (DM) on this subject. This UFC serves as criteria until such time as the full text UFC is developed from the Design Manual and other sources.

This UFC provides general criteria for designing general maintenance facilities.

Note that this document does not constitute a detailed technical design, and is issued as a general guide to the considerations associated with designing general maintenance facilities.

1-2 **APPLICABILITY.** This UFC applies to all Navy service elements and contractors designing general maintenance facilities.

1-2.1 **GENERAL BUILDING REQUIREMENTS.** All DoD facilities must comply with UFC 1-200-01, *Design: General Building Requirements*. If any conflict occurs between this UFC and UFC 1-200-01, the requirements of UFC 1-200-01 take precedence.

1-2.2 **SAFETY.** All DoD facilities must comply with DODINST 6055.1 and applicable Occupational Safety and Health Administration (OSHA) safety and health standards.

NOTE: All **NAVY** projects, must comply with OPNAVINST 5100.23 (series), *Navy Occupational Safety and Health Program Manual*. The most recent publication in this series can be accessed at the NAVFAC Safety web site:

www.navfac.navy.mil/safety/pub.htm. If any conflict occurs between this UFC and OPNAVINST 5100.23, the requirements of OPNAVINST 5100.23 take precedence.

1-2.3 **FIRE PROTECTION.** All DoD facilities must comply with UFC 3-600-01, *Design: Fire Protection Engineering for Facilities*. If any conflict occurs between this UFC and UFC 3-600-01, the requirements of UFC 3-600-01 take precedence.

1-2.4 **ANTITERRORISM/FORCE PROTECTION.** All DoD facilities must comply with UFC 4-010-01, *Design: DoD Minimum Antiterrorism Standards for Buildings*. If any conflict occurs between this UFC and UFC 4-010-01, the requirements of UFC 4-010-01 take precedence.

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APPENDIX A

DESIGN MANUAL 28.4

GENERAL MAINTENANCE FACILITIES

CCB Application Notes:

1. Character(s) preceded & followed by these symbols ([Ⓛ]Ⓜ) or (ⓇⓂ) are super- or subscripted, respectively.
EXAMPLES: 42m^{Ⓛ3} = 42 cubic meters
CO_{Ⓡ2} = carbon dioxide
2. All degree symbols have been replaced with the word deg.
3. All plus or minus symbols have been replaced with the symbol +/-.
4. All table note letters and numbers have been enclosed in square brackets in both the table and below the table.
5. Whenever possible, mathematical symbols have been replaced with their proper name and enclosed in square brackets.

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
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GENERAL
MAINTENANCE
FACILITIES

DESIGN MANUAL 28.4
SEPTEMBER 1984

ABSTRACT

Basic design guidance for general maintenance facilities covered by Category Groups 214, 215, 217, 218, and 219 is presented for use by experienced architects and engineers. The contents include design data for buildings and shop areas to provide for the repair and maintenance of motorized vehicles, weapons, electronic and communications equipment, miscellaneous procured items and equipment, and public works repairable items and equipment.

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FOREWORD

This design manual is one of a series developed from an evaluation of facilities in the shore establishment; from surveys of the availability of new materials and construction methods; and from selection of the best design practices of the Naval Facilities Engineering Command, other government agencies, and the private sector. This manual uses to the maximum extent feasible, national professional society, association, and institute standards in accordance with NAVFACENGCOM policy. Deviations from these criteria should not be made without prior approval of NAVFACENGCOM Headquarters (Code 04).

Design cannot remain static any more than can the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy, other government agencies and from the private sector and should be furnished to NAVFACENGCOM Headquarters (Code 04).

This publication is certified as an official publication of the Naval Facilities Engineering Command and has been reviewed and approved in accordance with SECNAVINST 5600.16.

W. M. Zobel
Rear Admiral, CEC, U. S. Navy
Commander
Naval Facilities Engineering Command

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28.2	2 & 5		Shipyard Maintenance Facilities
28.3	3		Maintenance Facilities for Ammunition, Explosives, and Toxics
28.4	4		General Maintenance Facilities
28.5	6		Environmental Control--Design of Clean Rooms
28.6	-		Aircraft Fixed Point Utility Systems

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GENERAL MAINTENANCE FACILITIES

Section 1. INTRODUCTION

1. SCOPE. This manual contains design criteria for buildings or other structures to provide facilities for the repair and maintenance of motorized vehicles, weapons, electronic and communications equipment, miscellaneous procured items and equipment, and public works repairable items and equipment.

2. CANCELLATION. This manual on general maintenance facilities, NAVFAC DM-28.4, cancels and supersedes Chapter 4, NAVFAC DM-28, Maintenance Facilities, of December 1974, Change 1 of January 1975, Change 2 of October 1975, and Change 3 of June 1976.

3. RELATED CRITERIA.

a. Definitive Drawings. Definitive drawings, where they exist for general maintenance facilities covered by this manual, are contained in Definitive Designs for Naval Shore Facilities, NAVFAC P-272, Part One and Definitive Designs for Marine Corps Facilities, NAVFAC P-272, Part Four, and are an integral part of the Naval Facilities Engineering Command's (NAVFAC) design program. Definitive drawings are listed in numerical sequence by the Navy category code number assigned to that facility. Definitive drawings associated with this design manual can be used for guidance in acceptable design principles related to specific functional layouts and operational requirements. The architectural treatment, materials, framing, and construction may vary.

b. Other NAVFAC Design Manuals. For criteria related to general maintenance facilities, but appearing elsewhere in the Design Manual series, see References.

c. Planning Criteria. Planning criteria for general maintenance facilities covered by this manual are contained in Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations, NAVFAC P-80, where each facility is listed in the numerical sequence by the Navy category code number assigned to that facility. This design manual does not contain criteria for some general maintenance facilities listed in NAVFAC P-80; therefore, the descriptions and criteria in NAVFAC P-80 should be used in the design of those facilities.

4. LOCATION. Siting of maintenance facilities shall be in accordance with the activity master plan.

5. DESIGN FLEXIBILITY. The changing requirements of a Navy activity demand flexibility in building design and usage. Obtain maximum flexibility by:

- o Spacing columns and selecting structural systems to satisfactorily accommodate both present and anticipated functional requirements.

- o Utilizing movable interior partitions.

6. SAFETY REQUIREMENTS. Requirements for personnel safety must meet the standards listed below:

a. Ventilation. The following ventilation systems shall be provided in accordance with Heating, Ventilating, Air Conditioning and Dehumidifying Systems, NAVFAC DM-3.3.

(1) Exhaust fans to remove fumes and toxic gases.

(2) Dust collectors to reduce explosion hazards.

b. Identification of Hazardous Areas. Hazardous areas shall be identified by means of colored safety markers on floors, columns, and structural elements projecting into circulation areas. (See Architecture, NAVFAC DM-1, Chapter 3, Section 5 and Color for Naval Shore Facilities, NAVFAC P-309, Chapter 5.)

c. Spacing. To ensure operator safety, specified aisle widths and spaces surrounding machines shall be maintained.

d. Collection Facilities. Bins shall be provided for shavings, scrapings, filings, and liquid coolant wastes.

7. LOADING DOCK RAMP PROTECTION. Each facility requiring a loading dock ramp shall be provided side edge protection in accordance with Section 1910.23c, Occupational Safety and Health Act Standards Manual.

8. ENERGY CONSERVATION. Energy conservation shall be a major consideration in the design of building envelopes, mechanical systems, and electrical systems for general maintenance facilities. (See NAVFAC DM-3.3 and Energy Budgets for New Facilities, NAVFAC Inst. 4101.1.) Each building envelope shall be insulated to provide the minimum heat transmission ("U") factors practical to meet energy budgets.

9. ENVIRONMENTAL CONCERNS. The maintenance facilities shall meet all applicable pollution abatement criteria. For applicable discharge criteria NAVFAC HQ and the cognizant EFD should be consulted. Also see NAVFAC Design Manual 5.8, Pollution Control Systems, Design Manual 5.9, Metering, Instrumentation and Control, and Chemical Feeding, and NAVFAC Inst. 4862.5A, Waste Control Projects Involving Wastewater, Chemicals and Toxic Substances.

It is essential that, as part of the preliminary studies, consideration be given to water conservation and source control, including the possibility of substantial alteration of the process or plant operation to reduce pollutant loading. The greater the volume of wastewater to be treated and the greater the amount of contaminant to be removed or destroyed, the higher are the capital, labor, and material costs required. Therefore, it is often economical to eliminate or reduce the quantity of waste at its source prior to treatment or in place of treatment. Several possible techniques exist including process change, material recovery, segregation, and waste reuse. Sometimes, with only partial purification, spent water can be reused, once or several times, in the industrial process. Water unsuitable for direct reuse may be serviceable for a different purpose in which quality requirements are less restrictive.

Often, there are a number of alternatives which can achieve the desired result. Therefore, a major objective of the preliminary studies should be to determine what combinations of actions will be the most cost-effective, as well as technically and operationally feasible.

10. BUILDING PROTECTION. The building structure of all general maintenance facilities, including corners of interior partitions and exterior walls, doors, structural members, etc., shall be protected from damage by vehicles and moving loads by the installation of concrete filled pipe guards, bumpers, railings, corner guards, and similar protective features.

11. FIRE PROTECTION. Fire protection for all general maintenance facilities, including considerations for building construction, life safety, hazardous conditions, extinguishing systems, and fire detection and alarm, shall be provided in accordance with Fire Protection Engineering, NAVFAC DM-8 as applicable to the specific building.

12. RESTRICTIONS ON THE USE OF UNCOATED ALUMINUM

a. Seacoast. Aluminum roofing and/or siding shall not be specified for structures located on or near the seacoast due to salt deposition or incrustation from inshore winds and salt-laden atmosphere.

b. Exterior and Interior. The restrictions for the use of preformed (corrugated) aluminum roofing and/or siding are applicable also to sandwich panel and flat sheet construction of unprotected (uncoated) aluminum and to ribbed aluminum extrusions. Consideration should also be given to the corrosion of aluminum surfaces on the interior of structures due to salt deposits from salt-laden air.

c. Incompatible Materials. All surfaces of incompatible metals, wet or green or damp wood, wood treated with incompatible preservatives, masonry, and concrete shall be isolated from direct contact with the aluminum by a heavy coat of alkali-resistant paint or by other approved means.

d. Coated Metal. Coated metal roofing and siding shall be in accordance with NAVFAC NFGS(TS)-07410, Preformed Metal Roofing and Siding.

Section 2. MOTORIZED VEHICLE MAINTENANCE FACILITIES

Part 1. PUBLIC WORKS TRANSPORTATION OPERATIONS AND MAINTENANCE FACILITY

1. FUNCTION. Transportation equipment maintenance facilities are required to provide covered work areas for inspection, maintenance, and repair of all transportation equipment assigned to an activity and, as applicable, other tenant commands. Covered facilities are essential in the maintenance and upkeep of the equipment fleet, in order to minimize or avoid the destructive effects of inclement weather and to achieve maximum productivity from maintenance personnel. For reasons of overall efficiency and economy, the transportation maintenance and operation facilities for automotive, construction/ weight-handling, and railroad equipment should be combined. (See Part 3 and Part 4 of this section for criteria for construction/ weight-handling equipment shops and railroad equipment shops, respectively, when the shops are not included with this facility.)

2. SPACE REQUIREMENTS.

a. Layout. The size of the facility to be used will be governed by the number of general repair bays needed, as computed from the tables and procedures set forth in NAVFAC P-80, for Category Code 214-20, Automotive Vehicle Maintenance Shop. General repair bays for this purpose are defined as that area required for inspection, maintenance, repair, and overhaul of transportation equipment. Several layouts for this facility, depending on the number of general bays required, are given in NAVFAC P-272, Part One. The size of a single general repair bay consists of a layout configuration 16 feet wide and 30 feet long. The basic design criteria incorporates drive-through features with two single bays end-to-end and thus results in a double general bay 16 feet wide and 60 feet long.

(1) In addition to the general repair bays, space is required for direct support areas and administrative and other indirect support areas. (See NAVFAC P-80, Category Code 214-20 for space requirements and NAVFAC P-272, Part One, for layout of these areas.)

(2) Repair bay support accessories for heavy construction/ weight-handling and railroad equipment differ in requirements from that of automotive. Consideration should be given to designating the necessary repair bay requirements for such equipment in one wing, or in a portion of one wing, as applicable. When railroad equipment is involved, consideration must be given to the track approach, since this can govern the location of the area selected for heavy equipment repair. (See Category Code 218-40, Railroad Equipment Shop, in NAVFAC P-80, for the number of repair bays with pits required.)

(3) Basic design features of the transportation repair facilities are flexible, and caution should be exercised when the final design is developed to ensure a reasonable balance of general repair bays in each wing. For example, assuming that 20 repair bays are determined as requirements to satisfy the needs of an activity, the design should provide for a symmetrical layout around the centrally-located administrative support area, with five double general repair bays located in each wing rather than eight bays in Wing 1 and two bays in the opposite wing. Further, in the development of requirements for a specific repair facility, consideration must also be given to

including only the other direct support areas required. Investigation can reveal that the activity has no requirements for a body shop, paint, or rigging shop as shown on the definitive drawings. In such cases, the design should be modified by excluding such work areas from the final design.

b. Direct Support Areas.

(1) When approved in the facility scope, the following direct support areas should be provided:

- (a) Engine and accessories overhaul bay.
- (b) Paint and lettering bay.
- (c) Body repair, glass, and welding bay.
- (d) Rigging bay.

(2) The other direct support areas that should be provided include the following facilities:

- (a) Tire service and repair bay.
- (b) Dynamometer test bay.
- (c) Battery service and repair bay.
- (d) Lube storage and compressor room.
- (e) Steam cleaning and wash bay.

c. Indirect Support Areas. The administrative and other indirect support areas include the following facilities:

- (1) Administrative office space for maintenance personnel.
- (2) Administrative office space for operations personnel.
- (3) Drivers and operators training, licensing, and ready room.
- (4) Lunch and conference rooms.
- (5) Male locker and toilet facilities.
- (6) Female locker and toilet facilities.
- (7) Parts supply, issue, and storage room.
- (8) Tool room.
- (9) Cleaning gear room.

3. ARCHITECTURAL AND STRUCTURAL REQUIREMENTS. Architectural requirements are given in NAVFAC DM-1 and as follows:

a. Structure and Walls. The building is to be of modular steel girder construction with insulated concrete masonry unit (CMU) walls, insulated preformed (corrugated) metal walls, or a combination of the two.

b. Roof Assembly. The roof shall be insulated metal panels or insulated built-up roofing assemblies which meet the requirements of Underwriters' Laboratories Building Materials Directory for fire-acceptable roof deck construction or Factory Mutual Approval Guide for noncombustible roof deck construction.

c. Floors.

(1) General Repair Bays. Concrete floor with hardener shall be provided.

(2) Wash and Steam Cleaning Bays. Concrete floor that slopes 1 inch in 8 feet to floor drain shall be provided.

(3) Dynamometer Test Bay. Vibration treatment shall be provided for floor and foundation.

(4) Battery Room. The battery room shall be designed in accordance with criteria in this manual, Section 5, Part 6.

(5) Aprons. Concrete aprons sloped to drain shall be provided.

d. Overhead Doors. Electrically operated insulated overhead doors shall be specified for general repair bays and other direct shop support areas. The width and height of the door openings shall be sized to permit easy passage of the vehicles that are to be maintained in the areas. Provide a means to manually operate doors in the event of power failure.

e. Personnel Doors. Outward swinging insulated doors shall be provided as required by Life Safety Code, NFPA 101.

f. Paint and Lettering Bay. In areas where spray application of paint is done, the area shall be in accordance with Spray Application Using Flammable and Combustible Materials, NFPA 33.

4. MECHANICAL REQUIREMENTS.

a. Heating. Heating shall be provided in accordance with NAVFAC DM-3.3. When a steam system is used for heating, if steam pressure is adequate, the piping arrangements shall be extended to the steam cleaning and wash bay to eliminate the need to operate a separate system in the winter months.

b. Ventilation. Ventilation shall be provided in accordance with NAVFAC DM-3.3. if the facility contains a paint and lettering bay, ventilation

to this area shall be provided in accordance with Industrial Ventilation, A Manual of Recommended Practice.

c. Air Conditioning. Air conditioning shall be provided in offices and administrative areas as allowed by policy in Department of Defense Construction Criteria Manual, DOD 4270.1-M. Air conditioning shall be provided in accordance with NAVFAC DM-3.3. Automatic thermostatic control shall be provided and equipment shall be shut down when not required for cooling.

d. Exhaust Systems. Exhaust systems shall be provided for the general repair bays and certain direct support areas in accordance with NAVFAC DM-3.3. The exhaust systems shall be mechanical ventilation systems designed and sized for efficient, energy conserving operation. For large facilities with numerous general repair bays, consideration shall be given to providing several exhaust systems rather than one exhaust system for a group of general repair bays. The use of several exhaust systems would reduce the size of the exhaust fans and minimize the need for operating a large fan when only a few bays are being used. An analysis should be made to determine the most energy efficient operation. The exhaust systems shall be provided for the areas listed and in accordance with the following additional requirements:

(1) General Repair Bays (Automotive). General repair bays designated for inspection, service, and repair of automotive equipment shall be equipped with an underfloor or overhead exhaust system as determined by projected usage and cost effectiveness.

(2) General Repair Bays (Construction/Weight-Handling Equipment). General repair bays designated for inspection, service, and repair of construction/weight-handling equipment shall be equipped with an overhead exhaust system with retractable flexible tubing outlets. When an overhead bridge crane is installed, powered roof mounted exhaust fans may be used for exhaust fume removal in lieu of the flexible tubing system. The roof mounted exhaust fans shall be sized and located for energy efficient operation.

(3) Dynamometer Test Bay. Exhaust system requirements for this bay are more extensive than for standard shop exhaust systems. The bay shall be equipped with an overhead exhaust system capable in size and capacity to remove excessive smoke and exhaust fumes which are generated from operating an engine under full load.

(4) Battery Service and Repair Bay. This bay shall be equipped with an exhaust system and battery charging equipment in accordance with criteria in this manual, Section 5, Part 6.

(5) Paint and Lettering Bay. This work bay, unless otherwise specified, shall be equipped with an exhaust system capable of removing vapors and gases from cleaners, solvents, and paints. The exhaust system shall be in accordance with requirements in NFPA 33.

(6) Body Repair and Welding Bay. The area designated for welding and body grinding shall be equipped with an exhaust system, with several flexible tubing outlets. These outlets are used to exhaust cutting and welding fumes from the work tables.

(7) Steam Cleaning and Wash Bay. The enclosed work area shall be equipped with an exhaust system capable of removing excessive steam vapors.

e. Lubrication System. The lubrication system for the facility should consist of centrally located equipment, including high and low pressure dispensing accessories and controls. The system will dispense lubrication materials through piping arrangements to a set of outlets in one, two, or three automotive general repair bays, and in one construction/weight-handling equipment general repair bay. Each set of outlets in the automotive general repair bays supports a bank of five overhead automatic retracting jube reels consisting of one chassis lube, two motor oils, one gear oil, and one hydraulic fluid. The set of outlets in the construction/weight-handling equipment general repair bays supports a bank of four overhead automatic retracting jube reels consisting of one chassis lube, one motor oil, one gear oil, and one hydraulic fluid. Metered dispensing accessories shall be provided for the motor oil, gear oil, and hydraulic fluid outlets. Requirements for the capacity of the lubrication system depend on the number of general repair bays in the facility. The system must be of sufficient size and capacity to support the size of the facility as follows:

(1) 4-10 General Repair Bays: One bank of five reels from the supply lines to the automotive area.

(2) 12-20 General Repair Bays: One bank of five reels from the supply lines to the automotive area and one bank of four reels from the supply lines to the construction/weight-handling equipment area.

(3) 22-40 General Repair Bays: Two banks of five reels from the supply lines to the automotive area and one bank of four reels from the supply lines to the construction/weight-handling equipment area.

(4) 42-48 General Repair Bays: Three banks of five reels from the supply lines to the automotive area and one bank of four reels from the supply lines to the construction/weight-handling equipment area.

f. Hydraulic Lift Systems.

(1) Hydraulic lifts shall be of the twin post or single post design, air-oil operated, and flush floor mounted. Hydraulic lifts with connecting rails above the floor surface when the cylinders are in a collapsed position are not considered satisfactory.

(2) Hydraulic twin post lifts shall be in accordance with Lift, Motor Vehicle, Type I, Class A, Size 1 or Size 2, Style a, Federal Specification 00-L-360. Light-duty twin post lifts will be Size 1 with wheel base requirements of 70 inches minimum and 166 inches maximum and total capacity of 11,000 pounds. Heavy-duty twin post lifts, if applicable for use in the facility, will be Size 2 with wheel base requirements of 78 inches minimum and 252 inches maximum and total capacity of 24,000 pounds.

(3) General repair bays designated for inspection, service, and repair of automotive vehicles shall be equipped with both light-duty and heavy-duty twin post lifts as indicated in NAVFAC P-272, Part One. Sufficient clearance shall be provided in the placement of the stationary cylinder to

permit closing the door when a vehicle is in a raised position. A staggering arrangement of heavy- and light-duty lifts should be used when installed in a double repair bay (end-to-end) in order to allow sufficient clearance for each lift within the 60-foot double repair bay limitation.

(4) Tire service and repair bay shall be equipped with one heavy-duty twin post lift, if applicable for use in the facility.

(5) Wash and steam cleaning bay shall be equipped with a single post front-end lift with a front-end lifting saddle.

(6) Hydraulic lifts are not required in general repair bays designated for brake and headlight inspection, service and repair bays designated for construction/weight-handling and railroad equipment, dynamometer test bay, engine and accessories overhaul bay, battery service and repair bay, paint and lettering bay, and body repair and welding bay.

9. Compressed Air, The compressed air system shall be in accordance with requirements in NAVFAC DM-3.5, Compressed Air and Vacuum Systems. The compressed air systems shall be adequate in size and volume to provide air for work bays, lubrication systems, air-oil operated hydraulic lifts, and service station facilities. One overhead air outlet mounted on an automatic retracting reel shall be provided for every two single general repair bays. Air outlets shall also be provided for tire service and repair bay, engine and accessories overhaul bay, battery service and repair bay, paint and lettering bay, body repair and welding bay, and steam cleaning and wash bay. Consideration shall be given to providing separate air compressor units complete with storage, controls, and accessories in several locations throughout the facility as compared to a single compressed air supply. An analysis should be made to determine the most desirable system in terms of energy conservation that will still ensure an adequate and reliable supply of compressed air.

h. Plumbing and Drainage. Plumbing and drainage systems shall be in accordance with NAVFAC DM-3.1 and the following requirements:

(1) A combination drain and grease trap shall be provided for the steam cleaning and wash bays. The grease traps for these areas must be of adequate size with removable grates to accommodate the excessive waste load. In addition, drainage shall be provided for the lift saddle sump of the single post hydraulic lift located in the enclosed steam cleaning and wash bay.

(2) The battery service and repair bay shall be equipped with an emergency shower and eyewash with floor drain and the necessary specially designed battery wash trays or sinks as required in accordance with NAVFAC DM-3.1 and this manual, Section 5, Part 6.

(3) All interior and exterior floor drains shall drain to an exterior oil separator.

(4) Potable cold water shall be supplied to a heavy-duty hose reel with control valve in each group of automotive general repair bays and in the construction/weight-handling equipment general repair bays.

i. Noise and Vibration Control. All mechanical systems and equipment shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10, Noise and Vibration Control of Mechanical Equipment.

5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with Electrical Engineering, DM-4.1, DM-4.2, DM-4.3, DM-4.4, DM-4.6, and DM-4.7, and as follows:

a. Electrical Fixtures. Electrical explosionproof, Class I, Division 1, Group D Fixtures and accessories shall be specified, where required by National Electrical Code, NFPA 70 and other applicable fire codes, for the service station facility, paint and lettering bay, and service pits for railroad equipment.

b. Shop Intercom System. A shop intercom system with requirements as determined by the using agency shall be provided.

c. Electrical Power Requirements.

(1) Single-phase, 120-volt, 20-ampere, 60-Hertz ac power shall be provided to heavy-duty electrical extension cord bose reels in the general repair bays. (See NAVFAC P-272, Part One.)

(2) Other electrical power shall be provided as required by the equipment in each area of the facility.

6. OVERHEAD WEIGHT-HANDLING EQUIPMENT. Overhead weight-handling equipment shall be provided in the work bays as indicated, when the work bay is included as a requirement for the facility. See Weight-Handling Equipment, NAVFAC DM-38.1 for criteria for overhead weight-handling equipment.

a. Engine and Accessories Overhaul Bay. One overhead monorail hoist assembly with 2-ton capacity shall be located at the centerline and run the full length of the bay. The hoist and motorized trolley shall be electrically operated with pendent pushbutton controls that can be conveniently operated at floor level.

b. Construction/Weight-Handling Equipment Bay. One overhead bridge crane with 6-ton capacity shall be located over the entire area as shown in NAVFAC P-272, Part One. The bridge crane bridge, trolley, and hoist shall be electrically operated with pendent pushbutton controls that can be conveniently operated at floor level.

c. Tire Service and Repair Bay. An overhead monorail hoist assembly with 1-ton capacity shall be located to run over the tire storage rack and into the work area. The hoist and motorized trolley shall be electrically operated with pendent pushbutton controls that can be conveniently operated at floor level.

7. SERVICE STATION FACILITIES. Island type service station facilities for dispensing gasoline shall be included and located as shown in NAVFAC P-272, Part One. The facilities shall be equipped with gasoline pumps and oil, air, and water dispensing accessories. Gasoline tank and piping materials shall be in accordance with Petroleum Fuel Facilities, NAVFAC DM-22. Additional requirements include:

a. Service Station Pump Island.

(1) The service station pump island shall be surrounded with a concrete apron. All dispensing accessories shall be equipped with automatic retracting mechanisms in order to minimize damage to accessories. All electrical accessories shall comply with all applicable requirements of NFPA 70. In order to provide some form of protection for service station records, accessory items and consumable supplies, include a small shelter located on one end of the pump island. The number of islands and gasoline dispensing pumps required for each facility will be governed by the number of pieces of equipment to be serviced. Requirements shown in Table 1 specify the number and type of dispensing pumps required, based on the number of vehicles or equipment supported.

(2) Fuel dispensing pumps shall be Underwriters' Laboratories, Inc. approved and shall be of either the single or double outlet type, as specified in Table 1, and shall be equipped with an automatic printing device. The fuel dispensing island shall be equipped with air and water outlets corresponding to the number of pumps located on the island. In addition, each island shall be equipped with adequate lighting for night servicing. When installation requirements specify two gasoline dispensing pumps per island, the piping arrangement shall be designed to permit drafting of fuel from either tank with either pump. In addition, the piping design for the service station island air and water should incorporate a shutoff arrangement from the main source of supply to permit draining the system when not in use or to prevent freezing during the winter months. Electrical installations must comply with NFPA 70 for hazardous locations.

b. Gasoline Vapor Recovery Equipment. Gasoline vapor recovery equipment shall be provided, or provisions shall be made for future installation, in accordance with local EPA requirements.

8. DIESEL FUEL DISPENSING FACILITIES. One island type diesel fuel dispensing facility shall be included and located as shown in NAVFAC P-272, Part One for those activities using diesel powered equipment. The diesel fuel dispensing island is separately located in order to minimize track type equipment damaging finished surfaces in the service station area and to accommodate railroad equipment. Additional requirements include:

a. Diesel Fuel Pump and Storage Tank. One single outlet diesel fuel pump and a 10,000-gallon underground storage tank are required when 250 or less units are to be supported. One double outlet pump and a 20,000-gallon underground storage tank are required when more than 250 units are to be supported. The pump shall be equipped with an automatic printing device and an explosion-proof motor. Diesel fuel tank and piping materials shall be in accordance with NAVFAC DM-22.

TABLE 1

Requirements for Gasoline Dispensing Pumps and Islands

Number of Units Supported	Pumps		Number of Islands	Air & Water Outlets	Storage Tank Capacities gal (under ground)
	Single outlet	Double outlet			
Up to 150	1	---	1	2	5,000
151 to 500	2	---	1	2	10,000
501 to 750	1	1	1	2	15,000
751 to 1000	---	2	1	4	20,000
1001 to 1500	---	3	2	4	30,000
1501 to 2000	---	4	2	4	40,000

b. Air and Water. The diesel fuel dispensing island shall be equipped with one air outlet and one water outlet, each with automatic retracting mechanisms. The piping design for the island air and water should incorporate a shutoff arrangement from the main source of supply, to permit draining the system when not in use or to prevent freezing during winter months.

9. EQUIPMENT PARKING AREAS (OPEN STORAGE). A preventive maintenance holding area and motor pool open storage lot located adjacent to the main transportation repair facilities shall be provided. Area requirements for the open storage lot shall be based on allowing 40 square yards per unit of equipment for approximately 75 percent of the equipment supported. The 40 square yards per unit takes into account such items as a mixed fleet of equipment, space requirements for entrance and exit roads, and aisles within the lot. Parking entrance and exit aisles within the lot should be approximately 30 feet wide, to permit adequate room for parking or removing vehicles or equipment. The surface material of the lot will depend upon the geographic location of the activity.

Part 2. PUBLIC WORKS TRANSPORTATION REFUELER REPAIR FACILITY

1. FUNCTION. The refueler repair facility is separate from the other public works transportation operation and maintenance facilities to remove the explosive hazard from these areas. For this reason, maximum practical clearance from other structures is essential. This facility provides for purging of fuel lines and tanks; safe disposal of flammable liquids; and overhaul, repair, and maintenance of refueling vehicles and other portable fuel dispensing equipment.

2. LAYOUT. This facility layout shall be in accordance with NAVFAC P-272, Part One and NAVFAC P-80, Category Code 214-30 for space allowance. Each maintenance and repair stall shall be 20 feet wide by 45 feet long and the purge pad shall be 16 feet wide by 45 feet long.

3. ARCHITECTURAL REQUIREMENTS. General architectural requirements are as given in NAVFAC DM-1 and as follows:

a. Structure and Walls. The building is to be of modular steel girder construction with insulated concrete masonry unit (CMU) walls, insulated preformed (corrugated) metal walls, or a combination of the two.

b. Roof Assembly. The roof shall be insulated metal panels or insulated built-up roofing assemblies which meet the requirements of Underwriters Laboratories' Building Materials Directory for fire-acceptable roof deck construction or Factory Mutual Approval Guide for noncombustible roof deck construction.

c. Floors. Concrete floor with hardener shall be provided in the maintenance and repair stalls. Concrete aprons sloped to drain shall be provided.

d. Overhead Doors. Electrically operated insulated overhead doors shall be specified.

e. Personnel Doors. Outward swinging insulated doors shall be provided as required by NFPA 101.

4. MECHANICAL REQUIREMENTS.

a. Exhaust System. The exhaust system shall be in accordance with requirements in NAVFAC DM-3.3. The maintenance and repair area shall be equipped with an overhead exhaust system with retractable flexible tubing outlets. The exhaust system shall be a mechanical ventilation system designed and sized for energy efficient operation.

b. Compressed Air. The compressed air system shall be in accordance with requirements in NAVFAC DM-3.5. The compressed air system shall be adequate in size and volume to provide air for two air outlets for the maintenance and repair area and one air outlet for the exterior Purge area. The air outlets shall be overhead outlets mounted on retractable hose reels. The air outlet located in the purge area shall be suitable for all-weather operation.

c. Heating and Ventilation. Heating and ventilation shall be provided in accordance with requirements in NAVFAC DM-3.3. Energy conservation shall be a primary consideration in the selection of heating and ventilation systems and equipment.

d. Air Conditioning. Air conditioning shall be provided in offices and administrative areas as allowed by policy in DOD 4270.1-M. Air conditioning shall be provided in accordance with NAVFAC DM-3.3.

e. Plumbing and Drainage. Plumbing and drainage systems shall be in accordance with NAVFAC DM-3.1, and as follows:

(1) All interior and exterior floor drains shall drain to an exterior oil/grease separator.

(2) An emergency shower with drain shall be provided in the maintenance and repair area.

(3) Potable cold water shall be supplied to two heavy-duty hose reels with control valves in the maintenance and repair area.

f. Noise and Vibration Control. All mechanical systems and equipment shall be designed to limit noise in accordance with NAVFAC DM-3.10.

5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, and DM-4.6. Electrical work shall be explosion-proof, suitable for Class 1, Division 1, Group D hazardous locations where required by NFPA 70 and other applicable fire codes.

Part 3. CONSTRUCTION/WEIGHT-HANDLING EQUIPMENT SHOP

1. FUNCTION. Special shop structures for the maintenance and repair of construction/weight-handling equipment are provided only where combined automotive, construction/weight-handling and railroad equipment are not feasible.
2. SPACE REQUIREMENTS. See NAVFAC P-80, Category Code 218-20 for space allowance for this facility.
3. DESIGN REQUIREMENTS. See Section 2, Part 1, Public Works Transportation Operations and Maintenance Facility of this manual for design requirements for this facility. Systems and equipment shall be provided, as described in Section 2, Part 1, that would be applicable to general repair bays for construction/weight-handling equipment. Other direct support areas and indirect support areas shall be provided as required.

Part 4. RAILROAD EQUIPMENT SHOP

1. FUNCTION. The railroad equipment maintenance facility is a special shop structure to house material and equipment for the service and maintenance of railroad locomotives and locomotive cranes. In areas where it is practicable, this facility is combined with the Public Works Transportation Operations and Maintenance Facility described in Section 2, Part 1 of this manual.
2. LAYOUT. See NAVFAC P-80, Category Code 218-40 for space allowance for this facility and NAVFAC P-272, Part One for the general layout of a one-bay facility.
3. DESIGN REQUIREMENTS. Architectural requirements shall be in accordance with NAVFAC DM-1. Heating and ventilation shall be provided in accordance with NAVFAC DM-3.3. Plumbing shall be provided in accordance with NAVFAC DM-3.1. All mechanical systems and equipment shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10. The bottom of each railroad pit shall be sloped to a center drain with all drains connected to an exterior oil separator. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, and DM-4.4.

Part 5. MARINE CORPS MOTOR VEHICLE MAINTENANCE SHOP

1. FUNCTION. The Marine Corps Motor vehicle maintenance shop is a special structure to house permanent shop facilities required by certain Marine Corps expeditionary units while in garrison. The facilities provide covered work areas for inspection, maintenance, and repair of all transportation equipment assigned to the unit, all diesel generators, converters, and air conditioners.
2. LAYOUT. The shop building includes administrative and support spaces. For the general layout of the facility see NAVFAC P-272, Part Four. A shop building for a Marine Corps air support squadron is similar except that air conditioner repair is omitted.
3. DESIGN REQUIREMENTS. See Section 2, Part 1, Public Works Transportation Operations and Maintenance Facility, of this manual for design requirements for this facility. Systems and equipment shall be provided as described in Part 1 that would be applicable to Marine Corps motor vehicle maintenance shops. Other direct support areas and indirect support areas shall be provided as required.

Section 3. WEAPONS MAINTENANCE SHOPS

1. FUNCTION. Weapons maintenance shops provide facilities for maintenance and repair of small arms, automatic weapons, mortars, artillery, guns, launchers, flamethrowers, torpedo tubes, harbor protective nets, and nonelectronic weapons equipment.

2. LOCATION. Siting of weapons maintenance shops shall be correlated with both personnel and vehicular traffic access.

3. ARCHITECTURAL REQUIREMENTS. The weapons maintenance shop, depending upon the overall function, normally consists of a mechanical bay, battery room, electrical bay, unpacking room, supply room, mechanical equipment room, office, male and female toilet rooms, a duty room, and classroom. The building construction shall be insulated concrete masonry units with the exception of a reinforced concrete wall between the office core and the shops. This wall shall extend a minimum of 3 feet beyond the building sides and the roof. Due to physical security and the need for air conditioning and humidity control, fenestration shall not be provided in exterior walls. Standard materials and finishes shall be as specified in NAVFAC DM-1. Special construction and finishes are as follows:

a. Special Flooring. Sparkproof concrete conforming to NAVFAC Guide Specification NFGS(TS)-09770, entitled Metallic-Type Static Disseminating and Spark-Resistant Finish, shall be used in the mechanical bay, electrical bay, and unpacking room.

b. Exterior Doors. Exterior insulated doors shall be security type with viewing ports, security hardware, and alarms.

c. Interior Doors. Interior doors in firewalls shall be 3-hour rated metal sliding doors and labeled openings in accordance with Fire Doors and Windows, NFPA 80.

d. Security Vestibule. A security vestibule, by which incoming personnel may be controlled and screened, shall be a part of the building design. This vestibule shall be a woven wire, full height cage with electric latched gates.

e. Loading Dock. A truck height loading dock shall be provided. The height of this dock shall be to industry standards unless otherwise specified by the using agency.

4. MECHANICAL REQUIREMENTS.

a. Ventilation. Ventilation shall be provided for mechanical and electrical bays in accordance with NAVFAC DM-3.3. Ventilation for the battery room shall be in accordance with Section 5, Part 6 of this manual. Mechanical exhaust systems shall be provided for weapons cleaning units to remove toxic fumes.

b. Air Conditioning. Temperature and humidity control shall be provided as required to prevent damage to weapons. Air conditioning for classrooms, duty rooms, and office areas shall be in accordance with NAVFAC DM-3.3.

c. Compressed Air. Low pressure compressed air shall be provided at 100 psi to all shop areas in accordance with NAVFAC DM-3. 5. Compressed air at pressure and capacity as required shall be provided to weapons cleaning units when the units are to be provided.

d. Plumbing. Plumbing shall be provided in accordance with NAVFAC DM-3.1. Floor drains shall be provided in mechanical bays, electrical bays, unpacking room, and supply room. Plumbing shall be provided for the battery room as required in Section 5, Part 6 of this manual.

e. Noise and Vibration Control. All mechanical systems and equipment shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10.

5. ELECTRICAL REQUIREMENTS. Electrical systemw shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, and DM-4.6.

6. WEIGHT-HANDLING EQUIPMENT. Overhead bridge cranes or monorail hoists, with capacity as required by the work done in the space, shall be provided for the unpacking room of all weapons shops and for the mechanical bay of heavy weapons shops. (See NAVFAC DM-38.1 for criteria for overhead bridge cranes or monorail hoists.)

7. SECURITY. Specific security requirements for the facility shall be obtained from the security office of the activity. Design guidance for the facility shall be obtained from NAVFAC DM-13.1, Physical Security.

Section 4. ELECTRONICS AND COMMUNICATIONS MAINTENANCE SHOPS

1. FUNCTION. The electronics and communications maintenance shops may include necessary facilities for maintenance and repair of radio and radar equipment, radiation aids, sonar equipment, transmission and reception equipment, and guided bombs. Maintenance and repair of nonairborne equipment for Navy and Marine Corps air stations may be done in ground electronics maintenance shops (GEM) where it is not feasible to effect repairs at the operating site. Included in GEM shops may be separate facilities for teletypewriter repair and indoor facilities for the repair of antennas and installed mobile electronic equipment.

2. LOCATION. The electronics and communications maintenance shops shall be located in the operational area of the installation being served and shall have both truck and rail access. The GEM shops need have only truck access. These shops shall be located in radio interference-free zones and the roof mounted radio and radar antennas shall be free of line-of-sight obstructions.

3. ARCHITECTURAL REQUIREMENTS. Standard materials and finishes for the electronics and communications maintenance shops and the GEM shop shall be as specified in NAVFAC DM-1. Special areas, construction, and finishes are as follows:

a. Special Areas.

(1) Teletype Room. The teletype room shall contain a cleaning and degreasing area of fire-resistive construction. In addition, this area shall have an emergency shower and eyewash with floor drain.

(2) Guided Missile Test Area. In complexes having guided missile repair capacities, there shall be a test area of approximately 10,000 square feet complete with required safety features.

(3) Crystal Fabrication Room. The crystal fabrication room shall be provided with etching tanks with appropriate vents and an emergency eyewash and shower with floor drain.

(4) Sonar Transducer Room. The sonar transducer room shall be of fire-resistive construction and shall contain cleaning vats, spray booths, oil storage, paint storage, and an emergency eyewash and shower with floor drain.

(5) Cryptographic Maintenance Room. In facilities containing cryptographic maintenance, this room shall be combined with teletype repair.

(6) Toilet Facilities. Toilet, locker, and shower facilities shall be provided for both male and female personnel.

(7) Paint Storage. A paint storage facility shall be provided similar to flammable storage facilities described in Section 14 of Aircraft Maintenance Facilities, NAVFAC DM-28.1.

(8) Paint Spray Areas. Paint spray booths or rooms shall meet the requirements of NFPA 33.

b. Floors. Battery charging rooms and rooms containing acid cleansing solutions shall have acid-resistant floor finishes and bases. A 10-foot by 10-foot level and smooth surface shall be provided in antenna repair work areas of air station GEM shops. A floor-level foundation shall be provided for mounting a tactical air navigation (TACAN) antenna.

c. Doors. Special size doors are required to facilitate the movement and handling of equipment. The electronics and antenna repair areas shall have 25-foot wide by 35-foot high, mechanically operated, rolling industrial doors. Mobile equipment repair bays of air station GEM shops shall have 12-foot wide by 14-foot high overhead doors. With the exception of air station GEM shops, other shops shall have doors wide enough to accommodate tractor-trailer trucks and high enough for vehicles carrying antennas. All exterior doors shall be insulated and weatherstripped.

d. Roof. Where required, the roof shall be designed for antenna mounts, loadings, and handling rooms. Roof walkways or safety coverings shall be provided at access ladders, hatches, and roof trafficways.

e. Ceiling Heights. Special ceiling heights are required in some spaces as follows:

(1) Forty-foot clearance where the testing of rotating antennas takes place.

(2) Ten-foot clearance in air station GEM shop antenna work areas.

(3) Fifteen feet in mobile equipment repair bays.

f. Soundproofing. Soundproofing shall be provided in teletype rooms and at office core perimeters in accordance with NAVFAC DM-1, Chapter 3, Section 4 and NAVFAC DM-3.10.

9. Shielding. Rooms for calibrating test equipment and meters shall be completely shielded with copper screening or shall be prefabricated as specified in NAVFAC Guide Specification NFGS(TS)-13765, Radio Frequency Shielded Enclosures, Demountable Type.

4. MECHANICAL REQUIREMENTS.

a. Heating and Air Conditioning. Heating and air conditioning shall be provided in accordance with NAVFAC DM-3.3. Constant temperature and humidity control shall be provided in a dust-free atmosphere in spaces for repair, testing, and calibration of equipment. Where a clean room atmosphere is required, clean rooms and/or clean benches shall be provided in accordance with Environmental Control-Design of Clean Rooms, NAVFAC DM-28.5.

b. Ventilation. Mechanical ventilation systems with makeup air as required shall be provided for cleaning and degreasing areas, cleaning vats containing toxic chemicals, rooms containing acids, sandblast rooms, and paint spray booths in accordance with NAVFAC DM-3.3. Ventilation for paint spray booths shall also meet the requirements in NFPA 33.

c. Vehicle Exhaust Systems. For air station GEM shops where electronic and communications equipment in vehicles is serviced, a mechanical vehicle exhaust system shall be provided to allow vehicles to run while mobile communication equipment is being serviced. The vehicle exhaust system should be an overhead system with retractable flexible tubing outlets or an underfloor system.

d. Plumbing. Plumbing shall be provided in accordance with NAVFAC DM-3.1, and the following:

(1) Acid sinks and drains lined with acid-resisting material shall be provided for areas where acids are used. A system shall be provided for collecting acid wastes before they are dumped into the sanitary sewer system. This collection system may be either dilution tanks or a holding tank with pH adjustment.

(2) Water wash curtain and drainage system shall be provided for paint spray booths.

e. Compressed and Vacuum Air. Compressed and vacuum air shall be supplied in accordance with NAVFAC DM-3.5, and the following:

(1) Low pressure compressed air at workbenches shall be provided in all shop areas.

(2) A vacuum cleaning system with outlets shall be provided throughout dust-free areas.

f. Noise and Vibration Control. All mechanical systems shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10.

5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4 Series and as follows:

a. Power Requirements.

(1) Single-phase, 120-volt, 20-ampere, 60-Hertz convenience outlets are required in all spaces.

(2) Three-phase 120/208-volt, 60-Hertz and 400-Hertz, and three-phase, 220-volt and 480-volt, 400-Hertz power is required for shop equipment. All 400-Hertz power supplies shall be regulated to eliminate error in calibration of equipment.

(3) Twenty-eight direct current power is required for shop equipment.

(4) The ampacity of three-phase and direct current outlets shall be as required by the using agency for the specific area.

(5) Suitable filters shall be provided for alternating and direct current equipment in the radio section.

(6) Electrical fixtures for paint spray areas shall be in accordance with NFPA 33.

b. Lighting. Interior lighting shall be an energy efficient type such as high pressure sodium vapor in high bay areas. Other interior lighting will normally be fluorescent. Lighting fixtures for paint spray areas shall be in accordance with NFPA 33.

c. Grounding. Two separate grounding systems are required. One system is for grounding the building structure, service entrance, and normal building equipment and the other is for grounding instruments. Resistance-to-ground in both systems shall be 25 ohms maximum.

d. Communications. An intercommunications system between the maintenance control office and each shop shall be provided.

e. Radar. Connection between radar antennas located on the roof and equipment located in the building shall be provided.

6. WEIGHT-HANDLING EQUIPMENT.

a. Overhead Equipment. Bridge cranes, jib cranes, and/or monorail hoists will be required in antenna repair and testing areas, packing and unpacking areas, and areas where heavy equipment is serviced. Overhead weight-handling equipment shall be electrically operated with capacity as required by the shop area and shall be in accordance with NAVFAC DM-38.1. Where weight-handling equipment is used for critical positioning operations, motors shall be controlled at slow speed for positioning loads and high speed for moving loads.

b. Elevators. Freight and/or personnel elevators shall be provided for multistory facilities.

7. SECURITY. Security shall be provided for the entire building as required for critical areas in Chapter 3 of OPNAVINST 5510.45. The cryptographic maintenance room shall meet the requirements for a classification of TOP SECRET in accordance with OPNAVINST 5510.1, Department of the Navy Information Security Regulation Program and OPNAVINST 5510.45.

8. MARINE CORPS FACILITY REQUIREMENTS. Marine Corps wing communications squadron in-garrison GEM shops are configured to accommodate mobile facilities when they are not deployed with the squadron. (See NAVFAC DM-28.1, Section 15, Marine Corp Aircraft Maintenance Facilities, for criteria which are applicable in these GEM shops.)

Section 5. MISCELLANEOUS EQUIPMENT MAINTENANCE SHOPS

Part 1. CONTAINER REPAIR AND TEST BUILDING

1. FUNCTION. A container repair and test facility services only empty containers. The facility provides for structural testing, minor repairs, and cosmetic services for damaged or structurally marginal containers.
2. LAYOUT. The size and a typical layout for a four bay facility are given in NAVFAC P-80. Space is required in the building for repair and test bays, administrative area, male and female locker and toilet facilities, parts and storage area, and a vending area. Outside storage space shall be provided adjacent to the facility for empty containers waiting to be repaired or reissued.
3. ARCHITECTURAL REQUIREMENTS. Architectural design shall be in accordance with NAVFAC DM-1. Electrically operated insulated roll-up doors shall be provided at both ends of each repair and testing bay. The width and height of the door openings shall be sufficient to allow the longest container that is anticipated to be repaired to be carried by forklift through the opening. A 5-ton overhead bridge crane shall be provided in the repair and test bay area.
4. MECHANICAL REQUIREMENTS. Heating and ventilation shall be provided in accordance with NAVFAC DM-3.3. Plumbing and compressed air shall be provided in accordance with NAVFAC DM-3.1 and NAVFAC DM-3.5. Low pressure compressed air at 100 psi shall be provided to each workbench in the work bays. The required utilities shall be provided for the vending area. Floor drains shall be provided for each work bay and the parts and storage area. All mechanical systems and equipment shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10.
5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, and DM-4.6. Lighting in the repair and test bays and exterior lighting for the covered storage area shall be an energy efficient type such as high pressure sodium vapor. Other interior lighting will normally be fluorescent.
6. WEIGHT-HANDLING EQUIPMENT. The overhead bridge crane shall be in accordance with criteria in NAVFAC DM-38.1. The bridge crane shall have electrically motorized bridge, trolley, and hoist with 5-ton capacity and shall be operated from floor level by pushbutton pendant controls.

Part 2. DRUM RECONDITIONING FACILITY

1. FUNCTION. The drum reconditioning facility consists of equipment required to maintain and recondition 55-gallon steel drums manufactured to Interstate Commerce Commission (ICC) specifications. Because of materials handled in drums and for safety purposes, this facility is normally contained in at least three buildings - one building for reconditioning, one building to isolate the welding repair operation, and one building for the boiler plant.

2. ARCHITECTURAL REQUIREMENTS. The buildings housing the drum reconditioning facility shall be insulated concrete masonry unit construction with standard construction and finishes as specified in NAVFAC DM-1. Special acid resisting finishes and equipment shall be provided as required by operational requirements. Storage facilities shall be provided for paint, lubricating oils, and caustic concentrates as described for flammable storage facilities in section 14 of NAVFAC DM-28.1.

3. OPERATIONAL REQUIREMENTS.

a. Operational Rules. Means for cleaning, reconditioning, testing, and repairing (if necessary) are required before reissue for all drums returned to a fuel facility for refilling or storage.

b. Drum Handling Procedures. Mechanical or gravity conveyances are required for moving drums to repair buildings. Conveying equipment is also necessary for moving drums through successive processing steps. These steps with principal machinery and other essential installations for each area are as follows:

(1) Drum Washing. Drum exteriors and interiors must be thoroughly cleaned of products previously contained. Equipment used includes:

(a) Automatic washer of enclosed type for cleansing with caustic solution containing up to 8 percent caustic concentration. The washer shall be provided with a sump for the solution and heating coils for heating solution to 130 OF.

(b) Pump with strainer and spraying equipment for interior praying of drum in head down, vertical position.

(c) Turntable for rotating drum while being externally sprayed.

(d) Electric motor for revolving spray heads. Automatic timing control of spraying cycle, adjustable between 1 and 3 minutes, shall be provided.

(e) Automatically controlled cycle, adjustable between 20 and 60 seconds, for live steam (15 psi) spraying, to rinse caustic from drums while drums are upended.

(f) Automatic drum loading and unloading to washing machine.

(g) Conveyor to move drums to next operation.

(2) Dedenting. This is done by applying an 80 psig internal water pressure. Equipment used includes:

(a) A holding stand for clamping drum heads with two plates, to prevent bulging under water pressure.

(b) Motor-driven water pump with sump and suitable drainage.

(c) Conveyor to either bypass this operation or move drums to next operation.

(3) Chaining. Where indicated after inspection of cleaned drum, this operation is to remove accumulated interior rust and scale. It is done by inserting 25 feet of chain into the drum and adding one quart of caustic solution (similar to washing). Equipment used includes:

(a) Stand with rubber-surfaced wheels and clamps for lock-in& a drum in place for rotation tilting.

(b) Means to actuate drum rotation and tilting, first toward one end and then toward the other.

(c) Timing equipment for oscillation and rotation for an approximate 20-minute cycle.

(d) High pressure spray nozzle for washing loosened scale and rust from drum interior after operation is completed.

(e) Conveyor either to bypass this operation or to move drums to next operation.

(4) Wire Brushing. This operation prepares drum exterior surfaces for painting. Equipment used includes:

(a) An enclosed machine, with exhaust ventilation, to shot-blast rotating drums and wire brush both heads and sides.

(b) Timing device to vary wire brushing time between 1 and 3 minutes.

(c) Automatic drum loading and unloading.

(d) Conveyor to move drums to next operation.

(5) Chime Rolling. The purpose of this operation is to straighten chimes and tighten them against leakage. Equipment used includes:

(a) Machine with suitable drum mounting stand and rollers which can apply sufficient pressure to the chimes.

(b) Means of rotating drums and heating the chimes during rolling to cause the chime sealing compound (in the drum when manufactured) to flow and ensure sealing. A hand blowtorch can be used for necessary chime heating.

(c) Conveyor to either bypass this operation or move drums to next operation.

(6) Testing. Testing is done with a 15 psig air test by either of two procedures. The equipment used and procedures are as follows:

(a) Procedure A. Use a stand for horizontal mounting of a drum, with hand rotation, while inspecting all chimes and side seams for leaks under a 15 psig internal air pressure. Apply soapsuds to all inspected areas to aid in leak detection.

(b) Procedure B. A water bath for drum submergence and leak detection shall be provided while under 15 psig internal air pressure.

(c) Conveyor. For either procedure, a conveyor shall be provided to move drums to the test stand and for subsequent operations.

(7) Welding. When necessary, drums can be repaired by welding. For fire safety, welding operations should be carried out in a separate building or shes. Equipment used includes:

(a) Suitable movable racks with rollers for drum handling during welding.

(b) A conveyor to move repaired drums to the test stand for retesting with 15 psig air pressure.

(8) Internal Preservation. Either before or after exterior painting, the interior of each drum is sprayed or fogged with 25 cubic centimeters of light preservative oil conforming to Lubricating Oil General Purpose Preservative (Water-Displacing Low Temperature), Federal Specification VV-L-800. A portable air spray gun is needed for this operation.

(9) Painting. Drums are externally painted and stenciled. Spray painting areas shall be in accordance with NFPA 33. Equipment used in the painting operation includes:

(a) Spray booth for manual spray painting, equipped with means for conveying drums horizontally, and rotating them during spraying.

(b) Exhaust fan in booth to remove paint fumes through a baffled water spray curtain. The booth bottom is designed as a water sump.

(c) Paint spraying equipment, designed for air pressures of 30 psig for spraying and 10 psig for drum stenciling. Furnish equipment for propeller agitation of paints.

(d) Preheater to heat drums using hot air to about 110 °F with conveyor of sufficient length so painted drums will be dry to touch after leaving a spray booth.

(e) Storage areas for paint curing. Suitable out-of-doors space shall be provided fur about a 4-hour paint curing time.

(f) Conveying equipment for automatic drum loading to a paint spray booth and for transfer to reconditioned drum storage areas.

4. MECHANICAL REQUIREMENTS. Mechanical equipment shall be provided as required in paragraph 3 of this part and as follows:

a. Heating. Heating shall be provided in accordance with NAVFAC DM-3.3.

b. Ventilation. Ventilation shall be provided in accordance with NAVFAC DM-3.3 and NFPA 33. Mechanical exhaust systems with 100 percent makeup air are required for the paint spray booth, welding area, and shotblast equipment.

c. Plumbing shall be provided in accordance with NAVFAC DM-3.1, and as follows:

(1) Emergency showers and eyewash fountains with drains shall be provided throughout the facility.

(2) Low pressure compressed air as required shall be provided for the drum handling equipment, shotblast equipment, paint spray equipment, and drum testing.

(3) Drainage as required shall be provided to safely dispose of caustic solution waste and to neutralize acid.

(4) Hot water, cold water, and steam for washing and rinsing equipment and the paint booth shall be provided as required. Cold water hosebibb outlets shall be provided for washdown of work areas.

(5) Adequate floor drains throughout the facility and adequate drainage of machines and paint spray booth sump shall be provided. The drainage system shall include paint and solvent traps.

d. Noise and Vibration Control. All mechanical systems and equipment shall be designed in accordance with NAVFAC DM-3.10.

5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, and DM-4.6. Electrical work shall be explosionproof, suitable for Class I, Division I, Group D hazardous locations where required by NFPA 70, NFPA 33, and other applicable fire codes.

Part 3. MECHANICAL EQUIPMENT CALIBRATION SHOP

1. FUNCTION. The mechanical instrument shop performs calibration, repair, and certification of all mechanical measurement instruments assigned to an activity.

2. LOCATION. This facility must be located where it will be free of vibration caused by surrounding activities.

3. ARCHITECTURAL REQUIREMENTS. Space is required for a repair and calibration area, storage for instruments waiting to be repaired or reissued, an office, and male and female toilets. Standard construction and finishes shall be used in accordance with NAVFAC DM-1. The facility shall be designed to provide a clean, dust-free environment. Doors shall be weatherstripped and insulated. For activities that repair instruments requiring a clean room type atmosphere, provide clean room areas or clean benches in accordance with NAVFAC DM-28.5.

4. MECHANICAL REQUIREMENTS.

a. Heating, Ventilation, and Air Conditioning. Heating, ventilation, and air conditioning shall be provided in accordance with NAVFAC DM-3.3. Inside design temperature for the repair and calibration area shall be 75°F with a relative humidity of 50 percent for cooling and 65 °F for heating.

b. Plumbing. Plumbing shall be provided in accordance with NAVFAC DM-3.1.

c. Compressed Air. Low pressure compressed air at 125 psi shall be provided to each workbench. The compressed air supply shall be instrument air quality. Multiple pressure regulators shall be provided at each workbench so that different pressures can be supplied concurrently for mechanical instrument calibration.

d. Noise and Vibration Control. All mechanical systems and equipment shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10.

5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, and DM-4.6.

Part 4. AIRCRAFT GROUND SUPPORT EQUIPMENT SHOP

1. FUNCTION. The ground support equipment (GSE) shop contains space and equipment for the maintenance of aviation ground support equipment at the intermediate level.

2. LOCATION. The ground support equipment shop should be located in close proximity to the aircraft maintenance hangars and parking aprons and shall have vehicular access. This shop should also be integral with or immediately adjacent to the GSE holding shed.

3. SPACE REQUIREMENTS. Overall space allowances for GSE shops are provided in NAVFAC P-80, under Category Code 218-60.

a. Main Work Area. The main work area shall be centrally located, flanked by the shops, offices, and locker and toilet facilities. Individual work areas shall be located to permit one-way through traffic and to provide convenient equipment access to the various shops.

b. Shops. The shops shall consist of space for engines, gas turbine compressors (GTC), electric repair, lead-acid battery cleaning and charging (including an external acid-neutralizing tank), equipment painting, ready issue, engine test, and tools. The test room shall be on concrete footings and foundation walls independent of the rest of the building. Shop spaces shall have overhead, sliding, or bifold doors.

c. Office Area. The office area shall consist of general division and training office space, production control offices, naval engineering technical specialist/naval aviation engineering service unit office space, training rooms, and coffee mess.

d. Lockers and Toilets. Locker, shower, and toilet facilities shall be provided for male and female personnel.

e. Exterior Facilities. A roofed-over area adjacent to the GSE shop shall be provided to wash equipment.

4. ARCHITECTURAL AND STRUCTURAL REQUIREMENTS. General construction and finishes shall be as specified in NAVFAC DM-1 and Structural Engineering, NAVFAC DM-2 Series, and as follows:

a. Structure and Walls. The building shall be of modular steel girder construction with concrete insulated masonry unit (CMU) walls, insulated preformed (corrugated) metal wall panels, or a combination of the two.

b. Roof. The roof shall be insulated metal panels or insulated built-up roofing.

c. Floors.

(1) Main Work Area. The floor of this area shall be concrete with hardener and designed for a live load of 20,000 pounds. Tire print dimensions shall be provided by the using agency.

(2) Shops. Concrete floor with hardener shall be provided.

(3) Battery Room. The battery room floor shall be designed in accordance with criteria in this manual, Section 5, Part 6.

(4) Other Areas. Floors of administrative and personnel spaces shall be designed for a loading of 100 psf, and provided with floor coverings as designated in NAVFAC DM-1.

d. Overhead Doors.

(1) Main Work Area. Electrically operated exterior equipment insulated access doors shall be 14 feet wide by 12 feet high.

(2) Shops. Electrically operated insulated overhead doors shall be specified for general repair bays and other direct shop support areas. The width and height of the door openings shall be sized to permit easy passage of the vehicles that are to be maintained in the areas.

e. Personnel Doors. Outward swinging insulated doors shall be provided as required by NFPA 101.

f. Hydraulic Lift. Flush floor mounted hydraulic lifts of 20,000-pound capacity shall be provided in the main work area and shops.

5. MECHANICAL REQUIREMENTS.

a. Heating and Air Conditioning. Heating and air conditioning shall be provided in accordance with NAVFAC DM-3.3.

b. Exhaust Systems. Exhaust systems shall be provided in accordance with NAVFAC DM-3.3 and as follows:

(1) Main Work Area and Engine Test Room. Overhead fume exhaust systems shall be provided for the main work area and the engine test room. The exhaust systems shall be mechanical ventilation systems designed and sized for efficient, energy conserving operation. Exhaust system components, including retractable flexible tubing outlets, shall be installed to preclude obstructing bridge crane or monorail hoist operations.

(2) Paint Shop. This shop shall be equipped with a mechanical ventilation system capable of removing vapors and gases from cleaners, solvents, and paints. Ventilation systems shall meet the requirements in NFPA 33.

c. Plumbing. Plumbing shall be provided in accordance with NAVFAC DM-3.1.

d. Battery Shop. Battery shop requirements shall be in accordance with Section 5, Part 6 of this manual.

e. Compressed Air. Low pressure compressed air at 125 psi shall be provided to the main work area and all shop spaces for pneumatic tools.

Compressed air will be required for hydraulic lifts when air-oil operated types are provided.

f. Noise and Vibration Control. All mechanical systems shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10.

6. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4 Series and as follows:

a. Power.

(1) Single-phase, 120-volt, 60-Hertz convenience outlets are required in all spaces. Convenience outlets in the main work area and shops shall be 30-ampere capacity and in other areas shall be 20-ampere capacity.

(2) Three-phase, 208-volt, 60-Hertz power is required in the main work area and all shops.

(3) Three-phase, 115/200-volt, 400-Hertz power is required in the electric repair shops.

(4) Twenty-eight direct current power is required in the electric repair shop and gas turbine compressor shop.

(5) The capacity of 3-phase and direct current outlets shall be as required by the using agency for the specific area.

b. Electrical Fixtures. Explosionproof fixtures and fittings, suitable for Class I, Division 1 or 2, Group D, shall be provided in all spaces in which solvents and paints are stored, mixed, or sprayed as required by NFPA 70, NFPA 33, and other applicable fire codes.

c. Communications. A 3M communications system outlet shall be provided in the production control office for connection to the aircraft intermediate maintenance department offices located in another building. (See NAVFAC DM-28.1, Section 1, paragraph 5.) Intercommunications systems shall be provided between selected offices and work spaces. A public address system shall be provided to reach interior and exterior work areas.

7. OVERHEAD WEIGHT-HANDLING EQUIPMENT. Bridge cranes or monorail hoists shall have electrically operated bridge and/or trolley and hoist with pushbutton pendent controls and shall be in accordance with criteria in NAVFAC DM-38.1.

Part 5. GROUND SUPPORT EQUIPMENT HOLDING SHED

1. FUNCTION. The ground support equipment (GSE) holding shed provides shelter and storage space for ground support equipment awaiting repair or issue.
2. LOCATION. The ground support equipment holding shed shall be adjacent to or in close proximity to the ground support equipment shops.
3. SPACE REQUIREMENTS. The space allowances for GSE holding sheds are provided in NAVFAC P-80, under Category Code 218-61.
4. ARCHITECTURAL AND STRUCTURAL REQUIREMENTS. The ground support equipment holding shed shall be a one-story protected preformed (corrugated) metal or concrete masonry unit structure with a minimum clearance of 10 feet. The floor shall be designed for live loads of 20,000 pounds. Paving shall be provided for equipment and vehicular access to the GSE shops. General construction and finishes shall be as specified in NAVFAC DM-1 and NAVFAC DM-2 Series. The entire GSE shop and shed area shall be protected against unauthorized entry by a lighted chain-link security fence in accordance with NAVFAC DM-5.12, Fencing, Gates, and Guard Towers.
5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, and DM-4.6.

Part 6. BATTERY SHOP

1. FUNCTION. The battery shop contains space and equipment for receiving, cleaning, testing, repair, charging, and issuing of batteries for ground support equipment and for aircraft.
2. LOCATION. The battery shop should be located in proximity to maintenance hangars and to the ground support equipment maintenance shop. Charger Room for charger units shall be separated from the Lead Acid Shop as required by Section 503-14 of the National Electrical Code.
3. SPACE REQUIREMENTS. The battery shop normally consists of a Nickel Cadmium (NICAD) shop and a lead acid shop. The NICAD shop is normally in a 22-foot by 21-foot area with layout as shown on Facility Plate (FP) No. 218-50, sheets 1 and 2. The lead acid shop is normally in a 28-foot and 8-inch by 21-foot area with layout as shown on FP No. 218-50, sheets 1 and 2. If toilet facilities are not available in a nearby adjacent facility, a central core area (toilet, office, and storage with janitor service sink) shall be provided between the two shops as shown on FP No. 218-50, sheet 2. Toilet may be used by male or female personnel.
4. FUNCTIONAL. Functional relationship diagrams are provided as FP No. 218-50, sheet 3. It is essential that there be no direct access between the NICAD shop and the lead acid shop. Refer to page 28.4-38, paragraph 9.b, for more details. Sections through shops are provided on FP No. 218-50, sheet 4.
5. ARCHITECTURAL AND STRUCTURAL REQUIREMENTS. Architectural and structural requirements for shops and central core area are given in NAVFAC DM-1 and DM-2 Series, respectively, and as follows:
 - a. Structure and Exterior Walls. The structure shall be constructed of steel roof joists on insulated masonry load bearing exterior walls or metal framing members with metal wall panel system (preformed (corrugated) metal exterior panels, insulation, and interior metal panel).
 - b. Roof. The roof shall be insulated built-up roofing or insulated metal roof panels.
 - c. Interior Partitions and Interior Side of Exterior Walls. Partitions shall be concrete masonry units (CMU) or metal finish panels as indicated in paragraph a.
 - d. Floors. Floors shall be concrete with finish in shops as given in paragraph 5.g. (3)
 - e. Charging Bench Floor Matting. Provide 3-foot wide non-slip matting in front of all charging benches. The matting shall protect personnel from electric shock and slipping hazards and shall conform to ASTM D 178, Rubber Insulating Matting, Class 2.

f. Ceilings.

(1) Shops. ceilings shall be water-resistant gypsum board on metal joists. Ceilings shall slope at a minimum of 1/2 inch per foot from the front to the back of the building, see sections A-A and B-B, FP No. 218-50, sheet 4. Openings in ceiling shall be limited to those required for air supply and exhaust. Air shall be exhausted from the high point of the ceiling at the back of the shops to prevent hydrogen gas accumulation within the shops.

(2) Central Core Area. Ceilings shall be gypsum board on metal joists or noncombustible suspended acoustical units.

9. Shops Interior Paint Finish. The NICAD shop and the lead acid shop shall be painted with an acid-alkali-resistant epoxy-urethane coating system as follows and shall conform to NFGS(TS)-09815, High-Build Glaze Coatings:

(1) The lower 4 feet of the walls shall be light blue for the NICAD shop and light pink for the lead acid shop.

(2) The upper walls and ceiling shall be white.

(3) The concrete floor shall be gray with a sand finish.

h. Central Core Interior Paint Finish. Inside face of exterior walls and partitions shall be painted white and conform to NFGS(TS)-09910, Painting of Buildings (field painting).

i. Work Surfaces. Work surfaces shall be acid-resistant and alkali-resistant in the lead acid and NICAD shops, respectively. Suitable material includes either corrosion-resistant steel, glass reinforced laminate or soapstone.

6. UTILITY REQUIREMENTS. Requirements are provided as FP No. 218-50, sheets 6, 7 and 8.

7. MECHANICAL REQUIREMENTS.

a. Heating and Air Conditioning. Heating shall be provided in accordance with NAVFAC DM-3.3. A separate heating system for each shop shall be provided so that air from the two shops is not allowed to mix. The heating systems shall be designed to maintain a minimum temperature of 680 F. Supply air for the lead acid shop shall be 100 percent outside air. Air conditioning shall be provided for the office area, when a central core area is provided, in accordance with NAVFAC DM-3.3 and DOD 4270.1-M. Air conditioning shall be provided in the NICAD shop when required to limit temperature to 85 OF and the shop is required to service batteries used aboard aircraft.

b. Ventilation. Ventilation shall be provided in accordance with NAVFAC DM-3.3 and as follows:

(1) Air exhausted from the shops shall be removed at the highest point of the ceiling which will be at the back of the building.

(2) The exhaust fan for the NICAD shop shall be sized to provide a minimum of one air change per hour. The exhaust fan should be sized larger when outdoor air can be used to limit shop temperature to 85 OF.

(3) The exhaust fan for the lead acid shop shall be sized to provide a minimum of 3 air changes per hour. The exhaust fan should be sized larger when required for mechanical ventilation cooling. The fan shall have a nonsparking wheel and the motor shall be located out of the airstream. The ventilation system for the shop shall be designed to provide a negative static pressure by exhausting 10 percent more air than is supplied. Supply air for the shop shall be 100 percent outside air.

(4) Exhaust fan for the toilet in the central core area shall be 2 cfm per square foot of toilet floor area.

(5) The exhaust vents in the battery shops shall be at the back of the building. Also, the exhaust and the air supply vents shall be the only recessed items in the ceiling of the shops.

c. Plumbing. Plumbing shall be provided in accordance with NAVFAC DM-3.1 and as follows:

(1) Acid-resistant and alkali-resistant floor drains shall be provided in the lead acid and NICAD shops, respectively.

(2) Emergency shower and eyewash facilities shall be provided with acid-resistant and alkali-resistant floor drains in the lead acid and NICAD shops, respectively. These facilities shall be provided within 25 feet (1620 mm) of the battery handling areas.

(3) Provide fiberglass holding tank (underground or above-ground) for waste electrolyte. Underground tank shall be located in a concrete containment pit with removeable waterproof cover. Above-ground tank shall be located on concrete slab with concrete berm around perimeter which provides containment' equal to tank volume plus 10 percent. Tank shall be located to provide gravity drainage from dump sinks. Provide float type level indicator, pump out connection and vent on holding tank. Sections through tanks are provided as FP No., . 218-50, sheet 5.

(4) Acid-resistant and alkali-resistant dump sinks shall be provided in the lead acid and NICAD shops, respectively. The sinks shall empty into a holding tank before disposal. Caution shall be exercised when separately pouring acid or alkaline waste. Acid and alkaline waste shall never be poured together into the sinks.

(5) Base cabinet sinks shall be the shallow photolab type and shall be acid-resistant and alkali-resistant in the lead acid and NICAD shops, respectively.

(6) Facilities, such as hose bidd, garden hose and rack, shall be provided for flushing and neutralizing spilled electrolytes for each shop.

d. Compressed Air. Compressed air shall be provided in accordance with NAVFAC DM-3.5. Low pressure (80 psi) compressed air shall be provided at each base cabinet sink and at the NICAD repair/rebuild bench in the NICAD shop. Compressed air supplies shall utilize adequate filters and dryers.

e. Noise and Vibration Control. All mechanical systems and equipment shall be designed to limit noise and vibration in accordance with NAVFAC DM-3.10.

8. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4 Series and as follows:

a. Alarm System. An alarm system shall be provided with trip lanyard between the emergency shower/eyewash and both sides of each charging bench. The alarm shall be connected to sound in an area that is manned when the battery shop is occupied, such as Supply Control and/or Fire Department.

b. Charging Circuits. The charging circuit (main and trickle) and exhaust fan in each shop shall be interlocked so that chargers will not operate unless fan is operating.

c. Electrical Power Requirements. Electrical power shall be provided as required by the equipment in each area of the facility and as follows:

(1) NICAD Shop.

(a) Single-phase, 115-volt, 60-Hertz, 15 ampere circuits to the charging benches as required.

(b) Single-phase, 115-volt, 60-Hertz, 20-ampere receptacles located as shown on FP No. 218-50, sheet 1.

(2) Lead Acid Shop.

(a) Single-phase, 115-volt, 60-Hertz, 20 ampere circuits as required for discharge units.

(b) Separate receptacles with appropriate circuits for each charger at the charging benches and for the trickle charger.

(c) Single-phase, 115-volt, 60-Hertz, 20-ampere receptacles located as shown on FP No. 218-50, sheet 1.

(3) Main Power Panel. The main power panel for each shop shall be within reach of the front doorway.

(4) Explosion-proof lighting fixtures and convenience outlets are not required in either shop.

(5) Lighting fixtures shall be suspended type fixtures rather than surface mounted or recessed type to prevent the accumulation of gasses within the fixture housing.

(6) See paragraph 5.e, page 28.4-34, for bench floor matting requirements.

d. Wiring Methods. Wiring methods for cable runs within NICAD or Lead Acid battery shops shall utilize silicone rubber insulated conductors within intermediate grade metal conduit or approved Type Mi or Type MC cable with UL approved and listed connections and terminations. Cables terminating within the room at lighting fixtures and other equipment shall be of unbroken lengths. Splices are not allowed. Cable runs shall be avoided through the battery shops except for cable runs that terminate in or cannot be routed around these spaces.

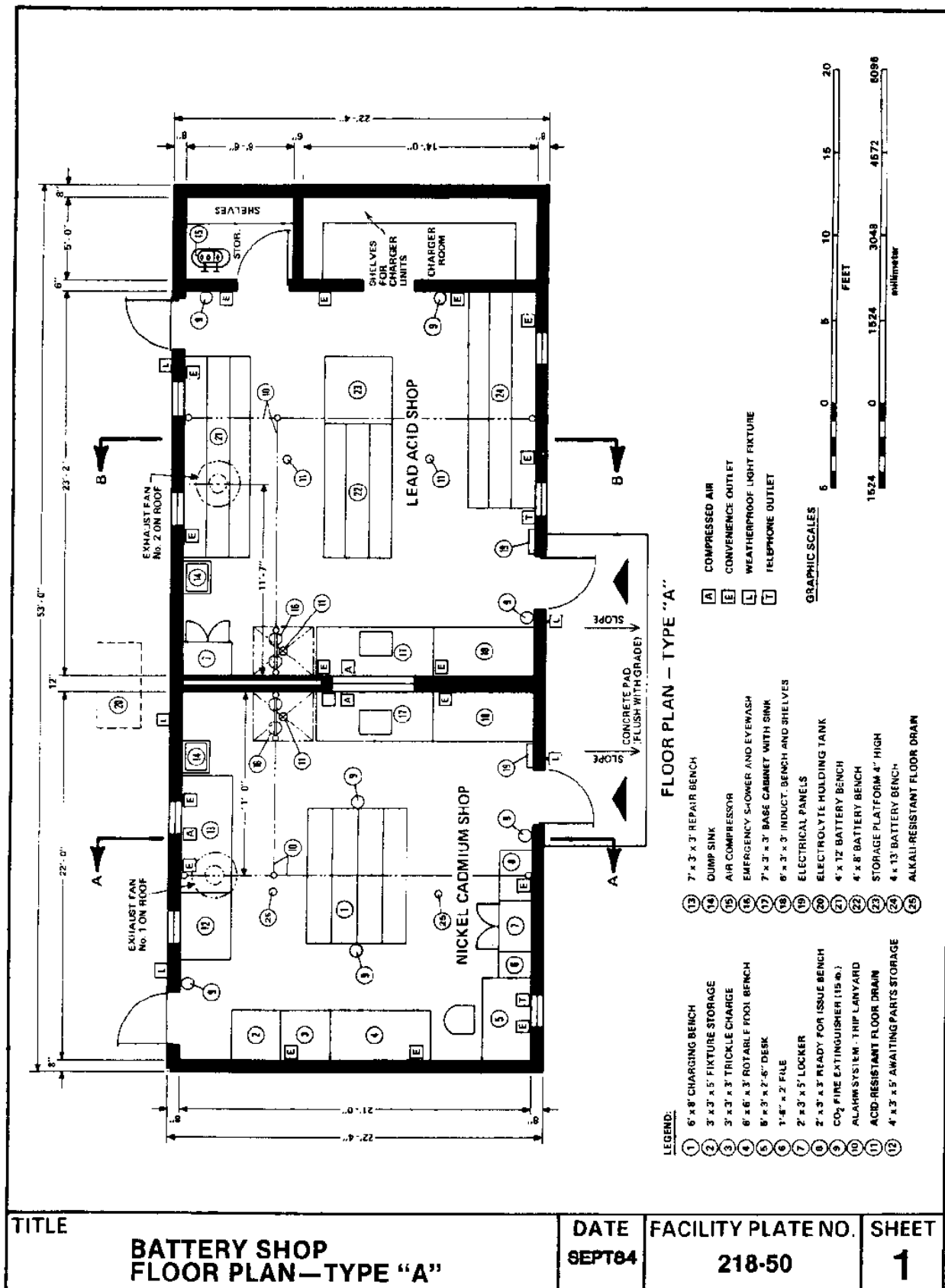
9. SECURITY AND SAFETY REQUIREMENTS.

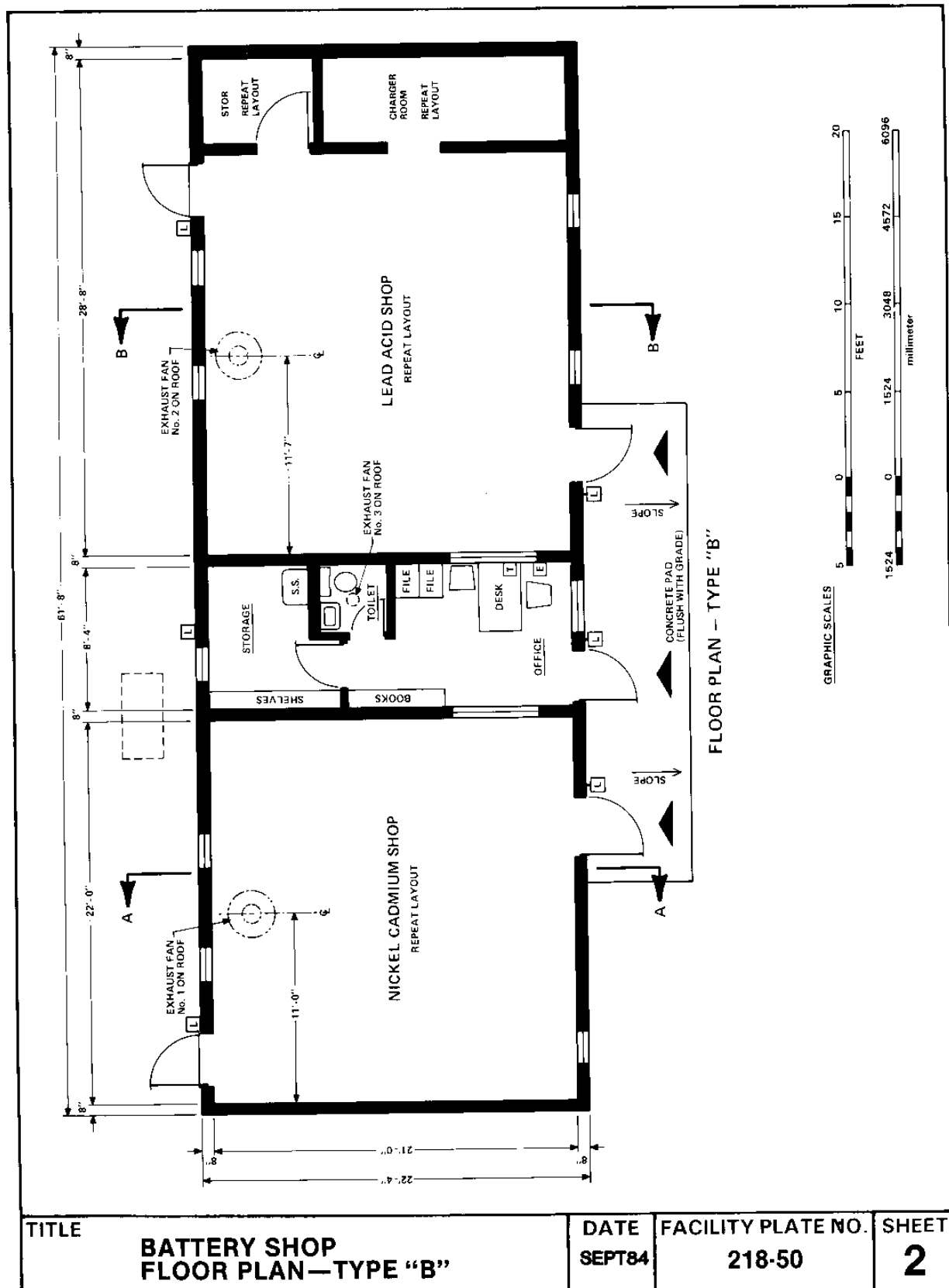
a. Door Lock. The door lock shall be the panic hardware type but a key shall be required to lock and unlock.

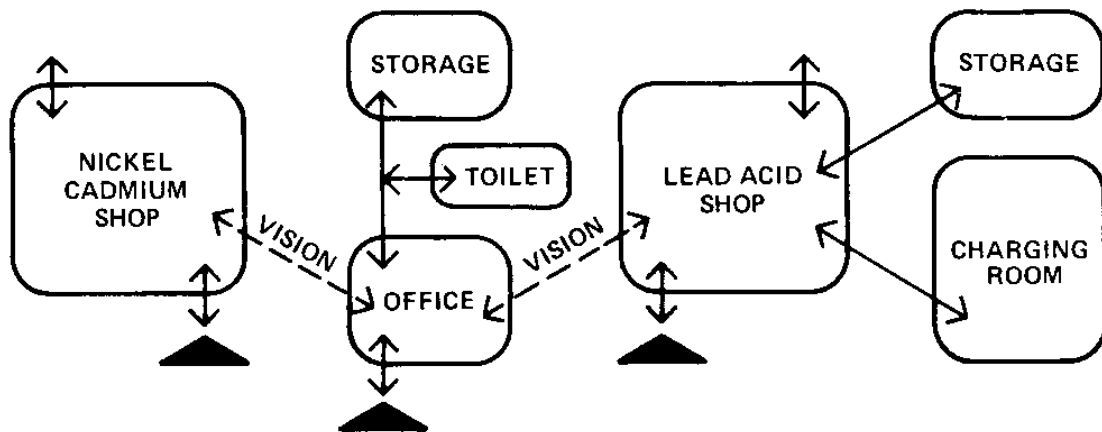
b. Openings. Doors or other openings shall not be provided between the NICAD and lead acid shops, other than a fixed wire glass window when a central core area is not provided. Two fixed wire glass windows shall be provided when a central core area is provided.

c. Entrance Door Sills. Sills shall be flush for safety.

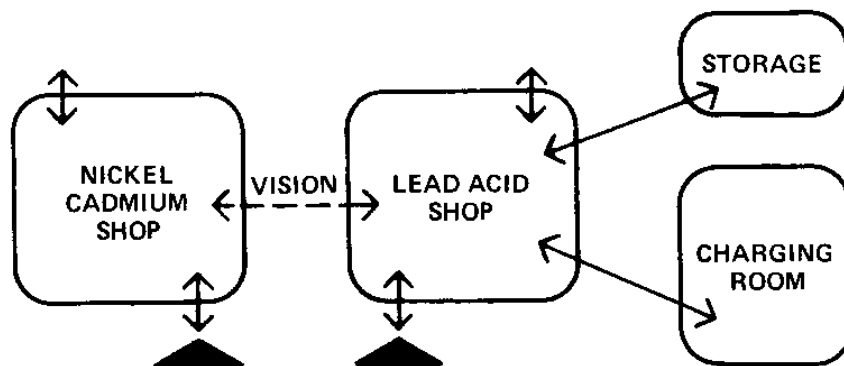
10. FIRE PROTECTION. The charging bench in the NICAD shop shall have a CO₂ fire extinguisher (15 lb) at each end to protect against thermal run-away. For fire protection requirements, see Section 1, paragraph 11.





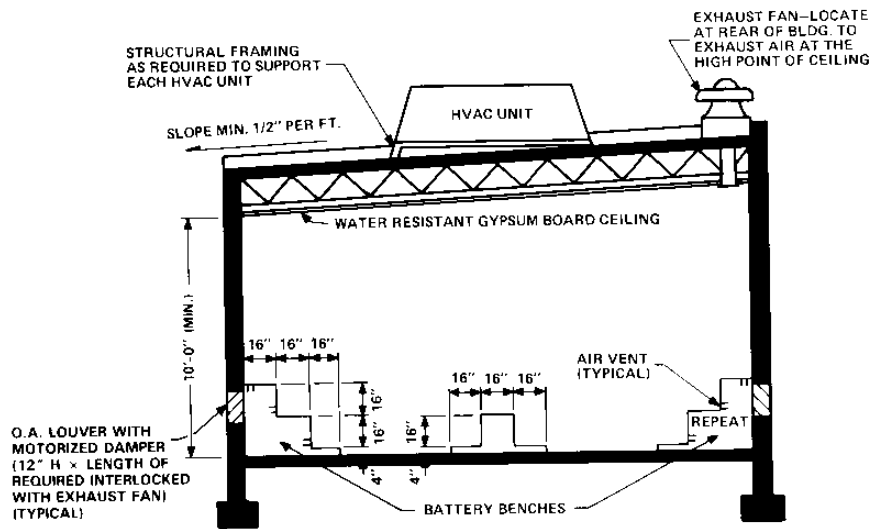


FUNCTIONAL RELATIONSHIP DIAGRAM –
FLOOR PLAN - TYPE "B"

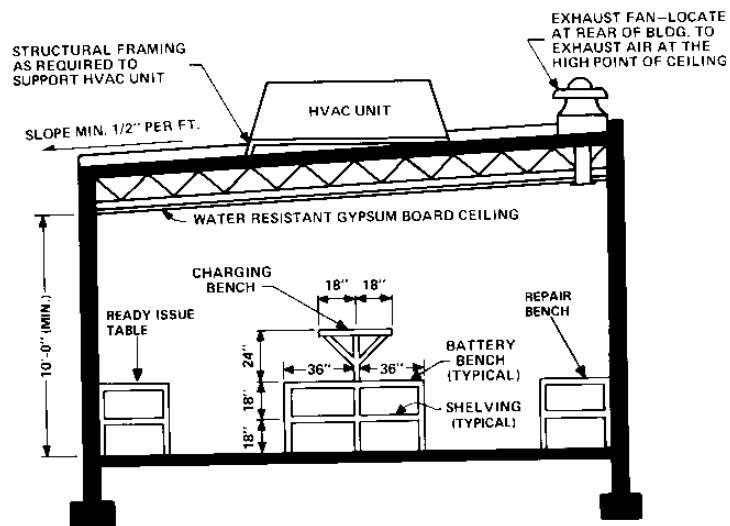


FUNCTIONAL RELATIONSHIP DIAGRAM –
FLOOR PLAN - TYPE "A"

TITLE	BATTERY SHOP FUNCTIONAL RELATIONSHIP DIAGRAMS	DATE	SEPT84	FACILITY PLATE NO.	218-50	SHEET	3
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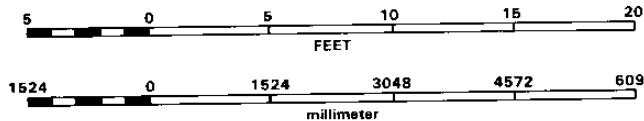


SECTION B-B

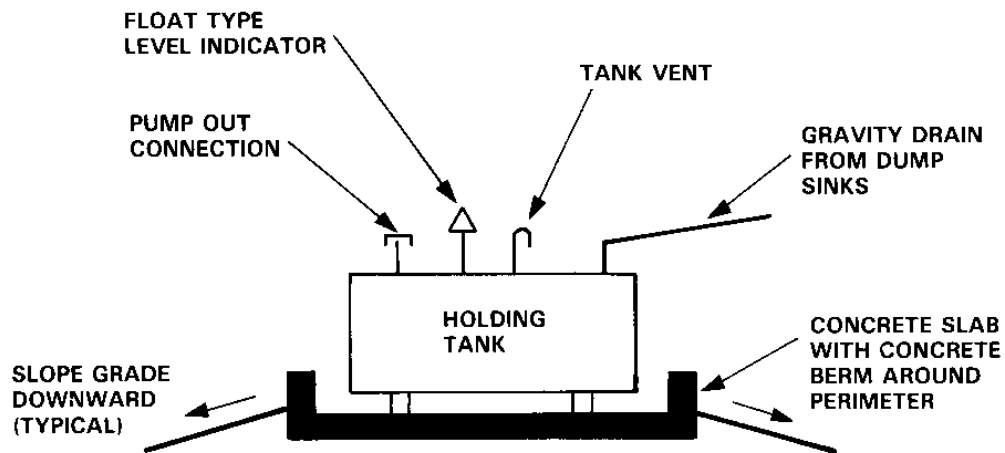


SECTION A-A

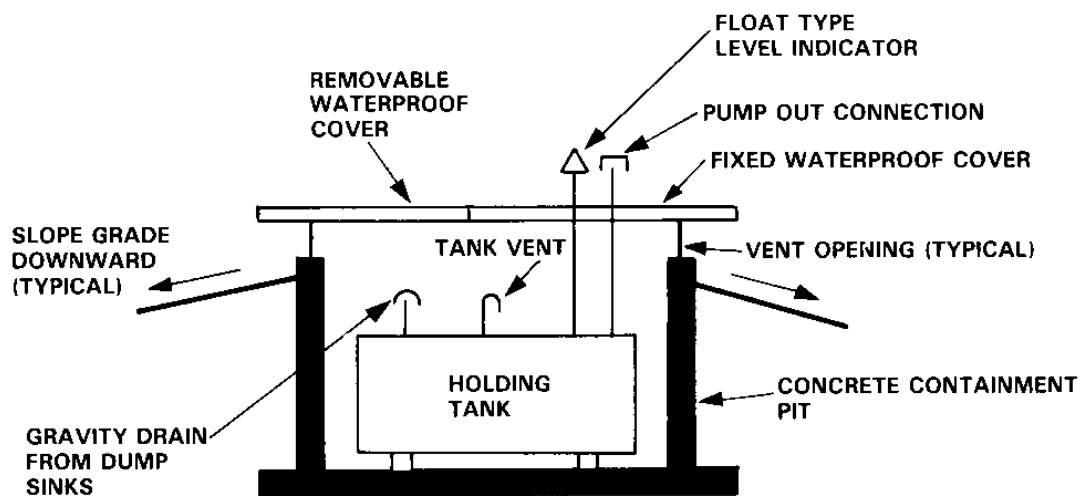
GRAPHIC SCALES



TITLE	DATE	FACILITY PLATE NO.	SHEET
BATTERY SHOP SECTIONS A-A and BB	SEPT84	218-50	4



ABOVE-GROUND TANK



UNDERGROUND TANK

NOT TO SCALE

TITLE	DATE	FACILITY PLATE NO.	SHEET
BATTERY SHOP HOLDING TANKS SECTIONS	SEPT84	218-50	5

ARCHITECTURAL

1. For guidance in the selection of Plan Types A or B, see paragraph 3 on page 28.4-34.
2. Provide exterior design and siting to suit project requirements.
3. The shop sizes indicated are for a typical automotive (Lead Acid) and/or aircraft (NICAD) with a maximum workload of 8 nickel cadmium and 40 lead acid batteries per work shift. For work loads different than this, the shop size should be modified. The major change for different work loads would be in the charging bench requirements.
4. Battery Shop Facilities and Battery Rooms shall comply with OSHA 1926.403 and 1910.178.

TOTAL GROSS AREA

Plan	Type	A	Facility	1,206 S.F.
Plan	Type	B	Facility	1,400 S.F.

MECHANICAL - Plan Types A and B

Plumbing:

Cold Water	15 GPM
Hot Water	
Recovery Rate (through 65° rise)	20 GPH
Storage	50 Gallons
Maximum Temperature	105°F

Heating:

Outside design temperature: Refer to NAVFAC P-89 "Engineering Weather Data".

Typical design load in MBH at various outside design temperatures.

-5°F	+5°	+15°F	+25°F
32	28	23	19

Inside design temperature: 68°F minimum for NICAD Shop

68°F maximum for Lead Acid Shop and Office

TITLE	BATTERY SHOP	DATE	FACILITY PLATE NO.	SHEET
	UTILITY REQUIREMENTS	SEPT84	218-50	6

Cooling:

Inside design conditions: 85° maximum for NICAD Shop

10°F temperature difference with
outside temperature for Lead Acid Shop
and Storage

78°F minimum for Office

Notes:

1. Mechanical utility requirements indicated above and on previous page are for estimating purposes only.
2. Heat gain from equipment in each shop = 5000 BTU/HR based on a maximum workload of 8 NICAD and 40 Lead Acid batteries per work shift.
3. All mechanical equipment and fixtures shall be specified to withstand the corrosive atmosphere.

Ventilation:

NICAD Shop	Minimum 1 air change/hr. Exhaust 100% directly to outdoors.
Lead Acid Shop	Minimum 3 air changes/hr. Exhaust 90% directly to outdoors. Room air recirculation is not allowed.

ELECTRICAL

Lighting:

	Plan Type A	Plan Type B
Connected Load	8Kw	10Kw
Estimated Demand	5Kw	6Kw

Power: (see note 2. on the next page)

Connected Load	75Kw	75Kw
Estimated Demand	45Kw	45Kw

Total:

Connected Load	83Kw	85Kw
Estimated Demand	50Kw	51Kw

TITLE	BATTERY SHOP	DATE	FACILITY PLATE NO.	SHEET
	UTILITY REQUIREMENTS	SEPT84	218-50	7

Notes:

1. Electrical utility requirements indicated on previous page are for estimating purposes only.
2. All electrical equipment and fixtures shall be specified to withstand the corrosive atmosphere.

FIRE PROTECTION

The CO₂ fire extinguishers located at the NICAD charging benches and Lead Acid Shop shall have a capacity of 15 lbs. These CO₂ fire extinguishers shall not be considered as part of the requirements of NFPA 10.

TITLE	BATTERY SHOP	DATE	FACILITY PLATE NO.	SHEET
	UTILITY REQUIREMENTS	SEPT84	218-50	8

Section 6. PUBLIC WORKS MAINTENANCE SHOP

1. FUNCTION. The public works maintenance shop provides for the maintenance, repair, and rehabilitation of existing installation facilities.

2. LAYOUT. NAVFAC P-272, Part One contains layout requirements for the public works maintenance shop in six different sizes, designated as Types A, B, C, D, E, and F. NAVFAC P-80 contains criteria for the allowable size of this facility in terms of the number of maintenance personnel permanently assigned to the maintenance organization. The individual shops shall be arranged within the overall facility to provide for efficient handling and working conditions, and to consolidate similar mechanical and electrical service systems. The shops shall be arranged with respect to other functional areas in consideration of related work activities, noise control, and cleanliness of operation. The support facilities such as central shop stores and toilet and locker room area shall be centrally located to serve as a buffer zone, separating the administrative areas and low-key activity shops from the more active (noise and dirt producing) facilities. Space for internal circulation of personnel and movement of materials shall be provided between all shop areas. Direct access to the building exterior for each shop space shall be provided for receiving and shipping of materials, and to avoid interfering with the activity of another area. A central aisle for internal circulation shall be arranged to serve both as a material handling area and a personnel corridor.

3. ARCHITECTURAL AND STRUCTURAL REQUIREMENTS. The structure for this facility shall provide for clear span construction independent of interior partition walls. The individual shops shall be column and barrier free with maximum flexibility for rearrangement of work stations. The type of interior partitions for the various shops and administrative areas shall be as shown in NAVFAC P-272, Part One. Construction, materials, and finishes shall conform to NAVFAC DM-1, NAVFAC DM-2 Series, and as follows:

a. General.

(1) Structure and Walls. The building shall be of modular steel girder construction with insulated concrete masonry unit (CMU) walls, insulated preformed metal walls, or a combination of the two.

(2) Roof.

(a) Roof Structure. The roof structure, where indicated in NAVFAC P-272, Part One, shall support a 2-ton monorail hoist assembly.

(b) Roof Assembly. The roof shall be insulated metal panels or built-up insulated roofing assemblies which meet the requirements of Underwriters' Laboratories Building Materials Directory for fire-acceptable roof deck construction or Factory Mutual Approval Guide for noncombustible roof deck construction.

(3) Entrances, Shops shall have individual entrances, consisting of a pair of flush insulated hollow metal doors, except for special purpose service areas. Each entrance shall have a concrete ramp from floor level to grade level. The doors at the ends of the central material handling aisle

should be power operated rolling steel doors. Pedestrian insulated doors may be provided adjacent to the larger doors for convenience of entry if required for the public works maintenance shop operation. Canopies or vestibules shall be considered for the main entrance to the administrative area depending on geographical location.

(4) Movable Interior Partitions. Partitions subject to change in floor plan layout shall be stock items with metal or gypsum board facings.

(5) Floors. The ground floor of the facility shall be concrete slab-on-grade. Resilient tile floor covering shall be used in offices. Exposed concrete with hardener shall be used in shops, storage areas, and locker facilities.

(6) Ceilings. Ceilings shall be exposed in all areas except the administrative area and shop supervision offices or other special purpose areas. Suspended acoustical tile ceiling shall be, provided in the administrative areas. Inverted acoustical metal deck or other suitable material for sound control shall be used for ceilings in the shop offices. A concrete slab ceiling of the required tire rating shall be provided over the flammable storage room in the shop stores.

(7) Windows. Shop supervision offices and other similar interior spaces shall have observation windows.

(8) Equipment and Furnishings. Provide equipment and furnishings as indicated in equipment schedules in NAVFAC P-272, Part One.

(9) Material Handling Aisle. Mounted items shall not project into the aisle more than 6 inches.

b. Areas with Special Requirements

(1) Administrative Area. The administrative area shall comply with requirements for the physically handicapped as stated in NAVFAC DM-1, section 6, paragraph 10.

(2) Carpenter Shop. Provide enclosure, including doors, taking noise and dust control into consideration.

(3) Moving, Rigging, and Wharf Building Shop. The roof structure shall support a 2-ton capacity monorail hoist.

(4) Shop Stores and Tool Room. Security ceilings at 10-foot height or full height walls are required. The flammable storage area shall have fire rated wall, door, and ceiling construction according to the nature of the stored materials.

(5) Pest Control Shop. Finish details shall avoid ledges where dust may accumulate. A finished ceiling shall be provided.

(6) Paint Shop. The design of the paint shop shall comply with requirements in NFPA 33.

4. MECHANICAL REQUIREMENTS. Mechanical equipment shall be provided as indicated in equipment schedules in NAVFAC P-272, Part One. Mechanical requirements are as follows:

a. Heating. Heating shall be provided in accordance with NAVFAC DM-3.3. Air curtain heaters shall be provided at the entrance doors at each end of the material handling aisle.

b. Ventilation. Ventilation shall be provided in accordance with NAVFAC DM-3.3. Separate units shall provide properly heated and filtered makeup air to the following areas with systems as described. The makeup air units shall be interlocked to operate only when required by the system in the shop.

(1) Carpenter shop with central dust collection system.

(2) Welding shop with welding booth.

(3) Electrical shop with vented hood.

(4) Paint shop with paint booth. Size unit so the supply air quantity is 10 percent less than the spray booth exhaust, and so that the area is maintained at a negative pressure in relation to the remainder of the building. Ventilation shall comply with requirements in NFPA 33.

c. Air Conditioning. Air conditioning shall be provided in shop offices and administrative offices as allowed by policy in DOD 4270.1-M. Air conditioning shall be provided in accordance with NAVFAC DM-3.3.

d. Lighting. Plumbing shall be provided in accordance with NAVFAC DM-3.1 and the following:

(1) Water and drainage systems, including paint and solvent traps, shall be provided for equipment in the following shops:

(a) Welding shop water quench tank.

(b) Paint shop spray booths.

(2) Emergency shower and eyewash shall be provided for the pest control shop.

e. Compressed Air. Compressed air shall be provided in accordance with NAVFAC DM-3.5. Low pressure compressed air at 125 psi shall be provided to each shop with outlets located conveniently throughout the shop for pneumatic tool use. Air compressor requirements are shown in equipment schedules in NAVFAC P-272, Part One.

f. Noise and Vibration Control. All mechanical systems and equipment shall be designed to limit noise in accordance with NAVFAC DM-3.10.

5. ELECTRICAL REQUIREMENTS. Electrical systems shall be provided in accordance with NAVFAC DM-4.1, DM-4.2, DM-4.3, DM-4.4, DM-4.6, and DM-4.7, and as follows:

a. Equipment. Electrical equipment shall be provided as shown in equipment schedules in NAVFAC P-272, Part One.

b. Power. Power to equipment shall be provided at phase, voltage, and capacity as indicated in the equipment schedules in NAVFAC P-272, Part One. Consideration shall be given to distributing power to equipment in the shops through underfloor duct systems arranged to provide maximum flexibility in equipment arrangement, where economically feasible. All areas shall be provided with adequate single-phase, 120-volt, 60-Hertz, 20-ampere convenience outlets.

c. Lighting.

(1) Interior lighting shall normally be fluorescent.

(2) Exterior lighting shall be energy efficient type such as high pressure sodium vapor where practical.

(3) Design for lighting intensities shall be in accordance with DOD 4270.1-M, Chapter 7.

d. Hazardous Locations.

(1) The paint shop electrical systems shall be in accordance with requirements in NFPA 33.

(2) The flammable storage area of the shop stores and tool room shall be treated as directed in Articles 500 and 501 of NFPA 70.

e. Communications. Service entrance telephone cabinets, conduit runs, and outlet boxes shall be provided for telephones. One telephone outlet shall be provided in each office of 100 square feet or less. In larger offices, allow 130 square feet per telephone outlet. Telephone closets may be used in the larger public work maintenance shops. A public address system shall be provided for paging to all shops and administrative areas.

6. WEIGHT--HANDLING EQUIPMENT. The monorail hoist shall have an electrically operated trolley and hoist with pushbutton pendent controls and shall be in accordance with criteria in NAVFAC DM-38.1. The monorail shall be located as shown in NAVFAC P-272, Part One. Forklift trucks and/or jib cranes shall be used to move materials or equipment in areas not served by the monorail hoist.

REFERENCES

ASTM Standards

D 178	Rubber Insulating matting
E 380	Standard for Metric Practice
E 621	Recommended Practice for the Use of Metric (SI) Units in building Design and Construction

ASTM Standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

DOD Publication

DOD 4270.1-M	Department of Defense Construction Criteria Manual
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DOD publication may be obtained from the Department of Defense, the Pentagon, Washington, DC 20301.

Factory Mutual Approval Guide, Factory Mutual Engineering Corporation, Norwood, MA 02062.

Federal Specifications

OO-L-360	Lifts, Motor Vehicle
VV-L-800	Lubricating Oil General Purpose Preservative (Water Displacing Low Temperature)

Federal specifications may be obtained from the U.S. Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120, TWX: 710-670-1685, AUTOVON: 442-3321.

Industrial Ventilation, A Manual of Recommended Practice, American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, P.O. Box 16153, Lansing, MI 48901.

National Fire Protection Association

NFPA 33	Spray Application Using Flammable and Combustible Materials
NFPA 70	National Electrical Code
NFPA 80	Fire Doors and Windows
NFPA 101	Life Safety Code

NFPA standards are available from the National Fire Protection Association, Boston, MA 02110.

NAVFACENGCOM Design Criteria

DM-1	Architecture
DM-2 Series	Structural Engineering
DM-3 Series	Mechanical Engineering
DM-4 Series	Electrical Engineering
DM-5 Series	Civil Engineering
DM-8	Fire Protection Engineering
DM-13.1	Physical security
DM-22	Petroleum Fuel Facilities
DM-28.1	Aircraft Maintenance Facilities
DM-28.5	Environmental Control - Design of Clean Rooms
DM-38.1	Weight-Handling Equipment
INST 4101.1	Energy Budget 3 for New Facilities
INST 4862.5A	Waste Control Projects Involving Wastewater, Chemicals, and Toxic Substances.
P-80	Facility Planning Factor Criteria for Navy and Marine Corps Shore installations
P-272, Part One	Definitive Designs for Naval Shore Facilities
P-272, Part Four	Definitive Designs for Marine Corps Facilities
P-309	Color for Naval Shore Facilities

Department of Defense activities may obtain copies of Design Manuals and P-Publications from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120. Department of Defense activities must use the Military Standard Requisitioning and Issue Procedure (MILSTRIP), using the stock control number obtained from NAVSUP Publication 2002.

Other Government Agencies and commercial organizations may procure Design Manuals and P-Publications from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20420.

NAVFACENGCOM Guide Specifications

NFGS(TS)-07410	Preformed Metal Roofing and Siding
NFGS(TS)-09770	Metallic-Type Static Disseminating and Spark-Resistant Finish

NFGS(TS)-09815	High-Build Glaze coatings
NFGS(TS)-09910	Painting of Buildings (field painting)
NFGS(TS)-13765	Radio Frequency Shielded Enclosures, Demountable Type

NAVFAC guide specifications are available, free of charge, from the U.S. Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. TWX: 710-670-1685, AUTOVON: 442-3321.

Occupational Safety and Health Act Standards Manual, Department of Labor, Occupational Safety and Health Administration (OSHA), Washington, DC 20210.

OPNAV Instructions

INST 5510.1	Department of the Navy Information Security Program Regulation
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INST 5510.45	United States Navy Physical Security Manual
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Government agencies may obtain OPNAV Instructions from the U.S. Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. TWX: 710- 670-1685, AUTOVON: 442-3321. The stock number is necessary for ordering these documents and should be requested from the NAVFACENGCOM Engineering Field Division in your area.

Non-Government organizations may obtain OPNAV Instructions from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Underwriters' Laboratories, Inc. Building Materials Directory, Underwriters' Laboratories, Inc., Northbrook, IL 60062.