

# **UNIFIED FACILITIES CRITERIA (UFC)**

## **DOCKSIDE UTILITIES FOR SHIP SERVICE**



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## UNIFIED FACILITIES CRITERIA (UFC)

### DESIGN: DOCKSIDE UTILITIES FOR SHIP SERVICE

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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

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This UFC supersedes Military Handbook 1025/2, Dockside Utilities for Ship Service dated May 1988.

## FOREWORD

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## CHAPTER 1 INTRODUCTION

### 1-1 PURPOSE.

This UFC provides design criteria and guidance in the design of utility systems for piers, wharves, and drydocks. Criteria are given for Type I Piers (Fueling, Ammunition, and Supply); Type II Piers (General Purpose Piers); and Type III Piers (Repair Piers.) Utilities covered include steam, compressed air, salt or non-potable water, potable water, oily waste/waste oil (OWWO) or petroleum, oil and lubricants (POL), CHT, electric power, and telecommunications.

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#### 1-1.1 Appendix C.

Appendix C contains tables of Ship Utility Requirements. These tables replace the Ships Characteristics Database (SCDB) and provide all information about ship utilities in a single resource (this UFC.) For information about USACE vessels, use the requirements for a similar Navy vessel or contact the cognizant USACE DISTRICT.

/1/

### 1-2 U.S. ARMY REQUIREMENTS.

U.S. Army vessel requirements for dockside utilities are contained in Chapter 7.

### 1-3 BACKGROUND

#### 1-3.1 General Information.

This UFC has been 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 (NAVFACENGCOM), other Government agencies, and the private sector. This UFC was prepared using, to the maximum extent feasible, national professional society, association, and institute standards. Deviations from this criteria, in the planning, engineering, design, and construction of naval shore facilities, cannot be made without prior approval of NAVFAC 4V4/ or USACE.

## CHAPTER 2 GENERAL UTILITY REQUIREMENTS

### 2-1 SHIPS DEMANDS.

Ships utility demands and other pertinent data for individual ships utilities are available from Appendix C. The designer must access this information in order to obtain the latest design data regarding dockside utilities for all ship services. In general, ship utility demands for active berthing are based on the ship's complement without deployed forces such as air wings or marine troops. Diversity factors are provided for use in determining demand in multiple berthing. If the designer is basing the project design on a specific ship that is not included in Appendix C, use data from a similar ship, or obtain the expected demand from NAVFAC 444/ or USACE. For graving drydocks, refer to UFC 4-213-10, *Design: Graving Drydocks*. This information is for use at new facilities and for use in additions, modifications, and replacements at existing facilities. While means of diversification are provided for multiple ships and multiple piers by these diversity factors, metered data from existing facilities and ships should be used for planning and design whenever such data are available.

### 2-2 UTILITY-CONNECTION LAYOUT.

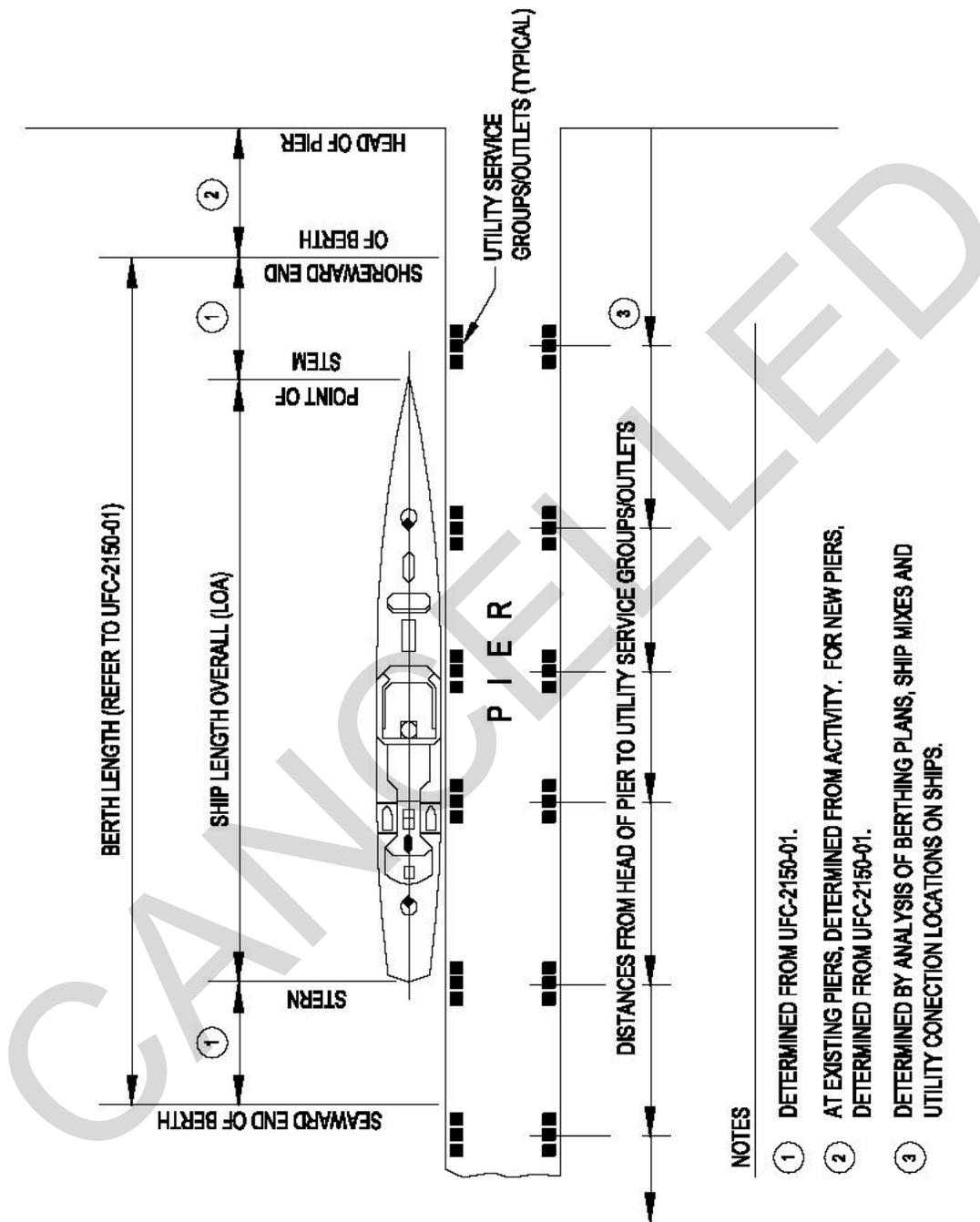
Figure 2-1 shows the dimensional relationships normally encountered in placement of shore utility connections. Appendix C provides size/shape data for typical ship hulls and dimensioned reference points that define the ship's utility connection locations. Ideally, the locations of shore utility connections for a given berth would simply correspond to their respective connection locations on the ship to be berthed. In practice, however, utility-connection locations can never be ideal, due to largely nondedicated berthing, interference with other pier or wharf activities, other deck equipment, and the grouping of connections. The designer must optimize the location of all utility outlet assemblies based upon the projected berthing mix.

#### 2-2.1 Connection Grouping.

Utility connections should be confined to specific locations along a shore facility so that interference with line handling and other facility operations is reduced. Connections may be in large groups to encompass all utilities, or may be in subgroups, such as the following:

- Freshwater, saltwater (if required), steam, and compressed air;
- Electrical power and communications;
- Sewer and oily waste; and
- POL, when required.

Figure 2-1 Typical Ship-Berth-Pier-Utilities Relationships



Regardless of the variations in utility groups that may be necessary to accommodate deck fittings and pier construction, sewer and oily waste connections must always be located 10 feet (3.05 m) or more from domestic water connections. Electrical outlet assemblies must be separated from other utility outlets by at least 10 feet (3.05 m) whenever possible. Additionally, where fueling is required, separation between such connections and electrical equipment is mandatory. See \4\ UFC 3-460-01 /4/, *Design: Petroleum Fuel Facilities* and consult with the cognizant Fire Protection Engineer to ascertain the minimum separation distances. Separation distances will vary depending upon the type of fuel or fuels.

### **2-2.2 Hose and Cable Lengths.**

Experience has shown that if utilities are to be grouped, not all of the shore connections can be placed optimally in regard to their respective ship connections, even at a dedicated berth. This being the case, the location of connections for certain utilities should be given preference in order to minimize required hose lengths. Preference should be given, in order of importance, to electrical power, fire protection water (if required), steam, sewage, oily waste collection, and potable water. Excessive hose and cable lengths have significant disadvantages as defined below.

#### **2-2.2.1 Electrical Power.**

Excessive lengths of power cable increase the possibilities of accident, fire, and excessive voltage drop.

#### **2-2.2.2 Fire Protection Water.**

Losses in the fire protection system hoses could be critical in the event of fire, particularly when ship's pumps are under repair.

#### **2-2.2.3 Steam.**

Steam hoses have a very short life, are expensive, and usually have high-pressure losses from shore to ship.

#### **2-2.2.4 Sewage.**

Although added hose pressure loss is not normally a problem, sewage hose is heavy, difficult to support, and must be disinfected when the ship's connection is broken.

### **2-2.3 Group Locations and Spacing.**

The locating dimensions for shipboard utility connections of various ship classes are presented in Appendix C. These dimensions, when used with the ships configuration drawings and the parameters given in this UFC, provide guidance in spacing determinations for the shore connections. The locations of required deck equipment (capstans, bollards, cleats, ladders, and railings) and deck operations (brows, cranes, dumpsters, etc.) must always be coordinated with locations of utility connections. Pier berthing plans (graphic plots) must be made for the most likely ship mixes, and should consider local berthing practices as defined by the Activity. The berthing plans provide the basis for the design and operations of the pier's utility systems and must be included

in the construction contract drawings when included under the design contract. Suitable shore connection spacing for the range of possible ships must be provided. Individual utilities within groups for mixed berthing should generally not be more than 200 ft (66 m) apart. Whenever possible, shore utility connection spacing should be such that connections are not offset more than 50 ft (15.24 m) from corresponding ships connections when other ship types occupy their prescribed berths.

## **2-3 UTILITY CONNECTION GROUP DESIGN**

### **2-3.1 Configurations to Avoid Interference.**

Utility outlet groups should be designed for minimum interference of hoses and cables with each other, with deck equipment, and with deck operations. Check weights of hose lengths and cables with crane's lifting capability. Outlet groups may be placed above deck or in deck pits. They may also be placed in open galleries below the main deck where the pier has sufficient elevation to avoid submergence of the utility connections. An example is a double-deck pier system such as Pier 6 at Naval Station Norfolk as shown in Figure 2-2. In order to avoid hose-connection difficulties and interferences with pier traffic, outlet connections should have centerlines parallel with berths or at not more than a 30-degree angle. The distance of connections from the pier face should be as short as is consistent with structural restraints and with convenience. However, on some aircraft carrier berths such as those using narrow breasting camels, locate the utilities to clear ship elevators. The type of connector at outlets must be compatible with hoses in use, or intended for use, at a given site. It is noted that the profile presented by utility groups above deck is dependent upon the height of the pier and the type of ship at berth. This is an important consideration in the design of dockside utilities for ship service. Mooring lines for ships such as destroyers are relatively low and present a greater hazard to utility connections. Low-profile utility outlet arrangements are usually preferred. Whenever possible, mooring line patterns for the specific ships to be berthed should be observed at a similar berth before utility group design is commenced. The berthing plans are to include mooring line patterns and must uncover conflicts with utility outlets. Some typical above-deck utility connection details are shown in figures in subsequent chapters. Other arrangements are also possible and may be acceptable. A specific arrangement may be required by the cognizant NAVFAC 41 FEC /4/ or USACE DISTRICT to match existing outlet designs. Required hose or cable connection types and sizes are given in individual utility descriptions in the following chapters. Provide for future expansion of utilities by the appropriate sizing of valve pits, pipe trenches, electrical vaults, and electrical duct banks. Likewise, a specific project may require the immediate design for future utility services. Lastly, always design for proper and safe access and maintenance of all utility systems.

### **2-3.2 Design for Nesting of Ships.**

Where berthing plans include the nesting of ships, provide a sufficient quantity of adequately sized services and connections. Design according to the number of ships that may simultaneously use each such berth. Unless instructed otherwise, provide internal shipboard port-to-starboard utility headers for all utilities except for potable

water. For potable water, use dual connections with individual backflow devices to provide separately protected supplies to two ships at each group location.

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Figure 2-2A Double-Deck Pier Example (1 of 3)

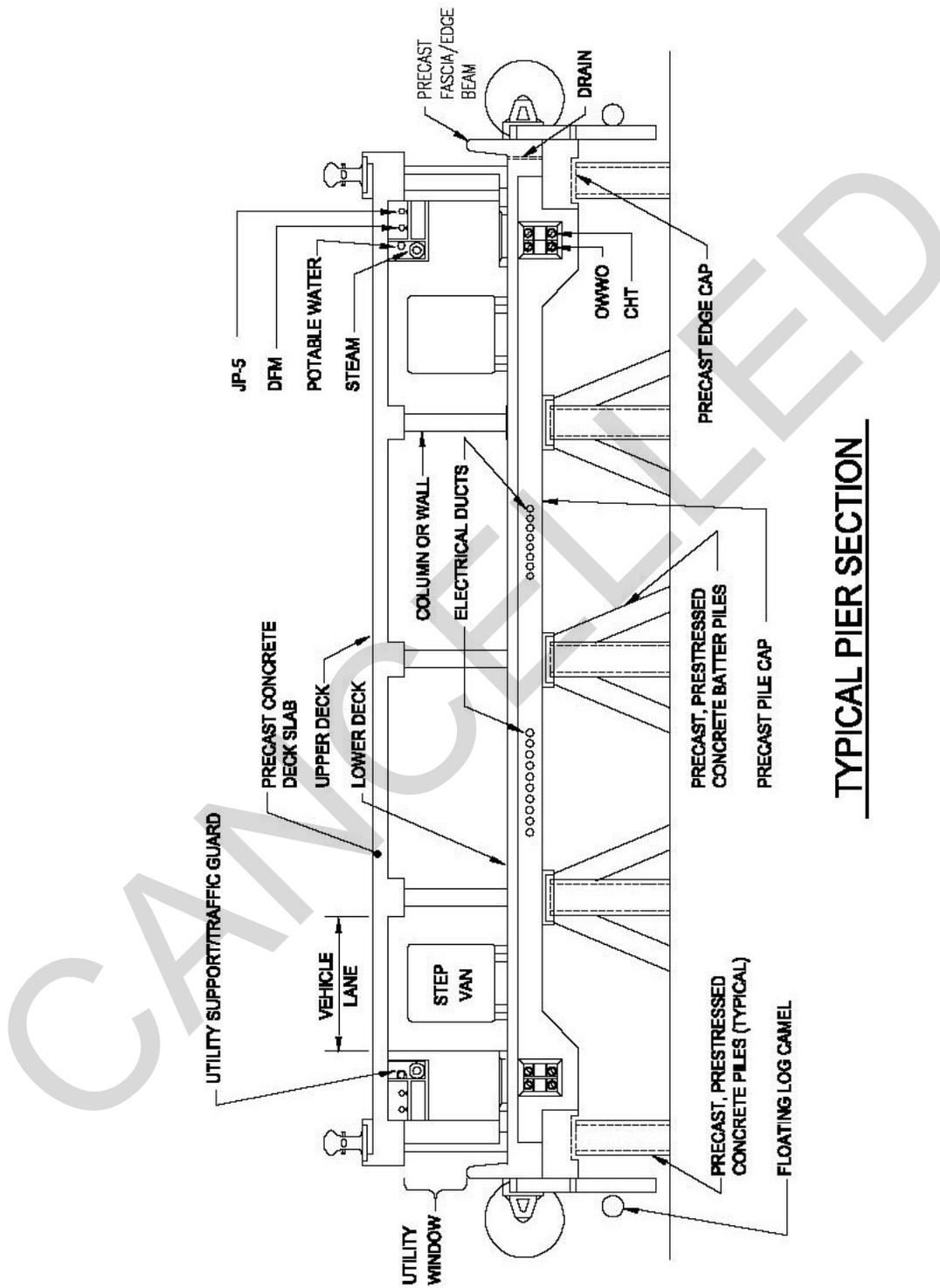
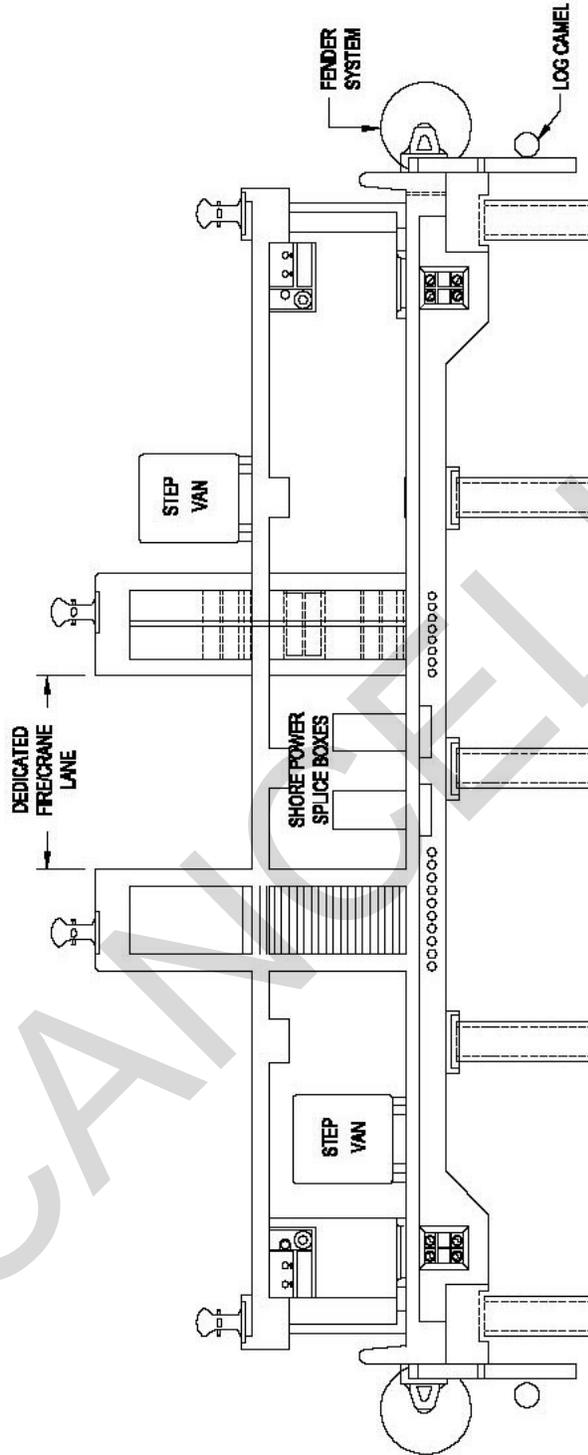
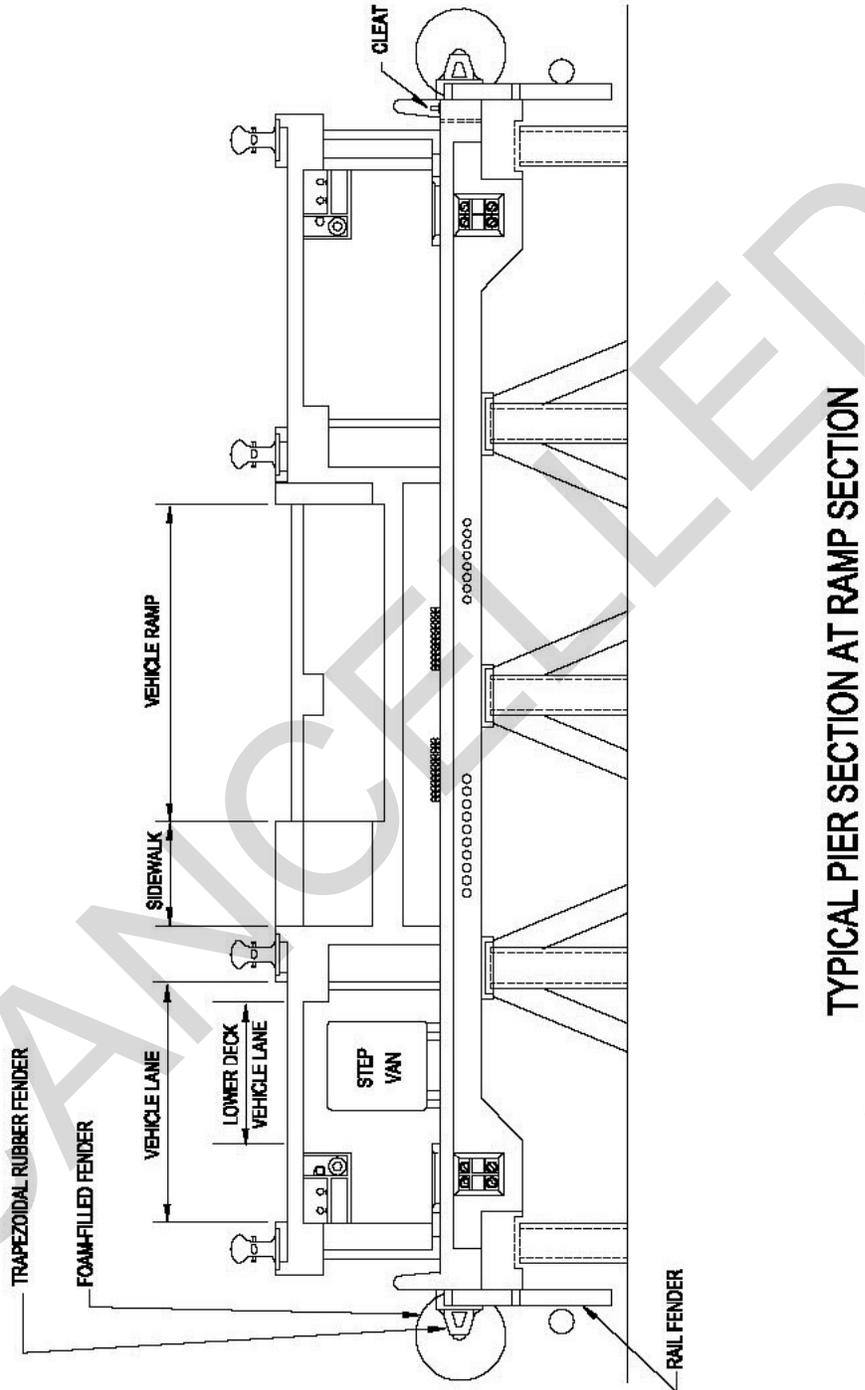


Figure 2-2B Double-Deck Pier Example (2 of 3)



TYPICAL PIER SECTION AT BOLLARD PLATFORMS

Figure 2-2C Double-Deck Pier Example (3 of 3)



## 2-4 PROTECTION

### 2-4.1 Protection of Mains and Laterals.

Mains and laterals serving utility connections must be protected from damage by waves, wind, floating debris or ice, and tidal immersion. Where these lines could be subjected to such damage, they must be placed in the utility corridor of a double deck pier, placed in the trenches or tunnels of a single deck pier, or special construction techniques must be used to provide a barrier. Electrical conduits may be embedded in new concrete structures. It is preferable to place electrical duct banks, manholes, and pull boxes such that they are cast integrally with the pier deck and at least 2 ft (0.6 m) above the mean high water level. There are cases where conduit and piping mains and laterals (except for POL systems) may be hung exposed from the bottom of pier decks in protected locations. This is not a preferred situation and is discouraged. In such cases, it is necessary to coordinate with the structural design to secure inspection ladders and deck inserts, and to facilitate installation of access platforms for maintenance purposes. New mains placed on existing piers may be placed on top of the pier deck if other construction techniques are impractical and if approved by the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. However, the use of utility trenches is highly preferred. Trench covers may be concrete, steel plate, grating, or a combination of these, and as dictated by structural loading, maintenance, and cost considerations. Coordinate design with structural requirements. Note that permanently fixed covers (concrete and steel) create confined workspaces. This is a significant operational problem (regarding inspection and maintenance) that is generally undesirable and should be avoided if possible. Identifiable markings should be located on the trench entrances. Corrosion protection requirements are defined in the following paragraphs. Requirements for POL systems are defined in paragraph 3-5 and refer to \4\ UFC 3-460-01, /4/ , *Design: Petroleum Fuel Facilities*.

#### 2-4.1.1 Above-deck Lines.

At most types of berthing facilities, clear deck space is at a premium, rendering above-deck mounting of utility services inappropriate, operationally difficult, and generally unacceptable. A notable exception to this general rule applies to dedicated fueling facilities. In these cases, above-deck mounting of fuel lines is often the most functional solution because it allows for the proper and safe access and maintenance of the fuel lines. See \4\ UFC 3-460-01 /4/ for additional information and criteria.

#### 2-4.1.2 Under-deck Lines.

Except as noted above, utility service pipelines should not be located on the operating deck. At single deck piers, utilities should be contained in trench structures, shielding the enclosed pipes from exposure to saltwater and spray. Utility trench covers are of three basic types: solid, solid with personnel access, and open gratings. Solid covers are generally used over most of the trench length. Solid covers with 30 in (760 mm) diameter manhole covers should be located over those portions of utility trenches containing valves, expansion mechanisms, or branch connections which require easy access for inspection, maintenance, and repair. Gratings may be substituted for solid

trench covers with personnel access wherever ready visibility of the respective utilities is required or where ventilation of trench is advisable (steam line drip assemblies). Unless specifically curbed against vehicular traffic, covers must be designed for the same uniform loads and wheel loads as the nominal pier deck with the exception that crane outrigger reactions need not be addressed. It is therefore necessary that utility trenches not be located within the pier cross-section where mobile cranes are likely to position their outriggers.

#### **2-4.1.3 Hangers and Support Assemblies.**

Hangers, bolts and specially fabricated supports and braces must be hot-dip galvanized after fabrication or constructed of reinforced fiberglass support systems including fiberglass support rods and hardware. Many Activities prefer the state-of-the-art fiberglass support systems. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Where salt spray exposure is severe, incorporate appropriate additional anticorrosion measures for hangers. This includes the application of epoxy coatings, the use of stainless steel or monel bolting, and the use of fiberglass/resin composite hangers and bolting. Refer to Naval Facilities Engineering Service Center (NFESC) TDS-2025-SHR, *Polymer Composite Utility Pipe Hangers*. Lastly, hangers must be designed based upon the maximum potential weight of the utility system. For example, for steam piping, allow the piping to be full of water.

#### **2-4.2 Protection of Utility Connections.**

Means to protect utility connections, hoses, and cables from damage due to traffic and snagging by mooring lines are essential. Conventional protection schemes consist of curbs, pits, concrete structures, or railings. Where pier width is sufficient, consider the use of continuous curbs located at sufficient distance from the edge of the pier. The design should exclude pier traffic from the areas containing utility connections, hoses, and cables. Where utility pits are used, sufficient pit length must be incorporated to ensure that hoses may be connected and led from pits to ships without kinking or chafing.

##### **2-4.2.1 Outlets, Connections, and Access Hatches.**

Access hatches in decks should have flush-mounted covers and must be designed to eliminate any danger of tripping. Where outlets and connections must appropriately protrude above the deck level, shield them in a manner that will ensure personnel safety and prevent mooring lines from being snagged on the piping and equipment. Certain utility connections such as sanitary sewer, fuels, oily waste, and waste oil must be contained within a curb or vault. Provide a drainage system to an appropriate collection system. Additionally, fuel hoses must be provided with a curbed lay-down area for the collection of drippings. Also, refer to \4\ UFC 4-152-01, *Design: Piers and Wharves /4/*, for other typical details.

#### **2-4.3 Seismic Protection**

##### **2-4.3.1 Performance of Utility Lines.**

Provide special and detailed considerations for seismic protection. This applies to pierside utility systems and the associated landside utility systems. Specific details are required for storage structures and the interface transition between the landside systems and the pierside systems. Except POL lines, design all piping and utility lines as "essential" construction. See \4\ UFC 4-152-01, *Design: Piers and Wharves I4/*. (The design requirements for POL lines are defined in the following paragraph.) In general, essential construction is expected to:

- Resist the maximum probable earthquake likely to occur one or more times during the life of the structure (50 percent probability of exceedance in 50 years) with minor damage, without loss of function, and the structural system to remain essentially linear.
- Resist the maximum theoretical earthquake with a low probability of being exceeded during the life of the structure (10 percent probability of exceedance in 100 years) without catastrophic failure and a repairable level of damage.

#### **2-4.3.2 Performance of POL and Hazardous Utilities.**

Design lifeline service associated with construction categorized as containing "hazardous materials" with the same levels of service. In general, hazardous material containment construction is expected to:

- Conform with criteria for essential construction.
- Resist pollution and release of hazardous materials for an extreme event (10 percent probability of exceedance in 250 years).

#### **2-4.3.3 Liquefaction.**

Design of structures should include provisions to evaluate and resist liquefaction of the foundation and account for expected potential settlements and lateral spread deformation. Refer to \4\ UFC 3-220-10N, *Soil Mechanics I4/*. Special care must be given to buried pipelines in areas subject to liquefaction to preclude breaks resulting in release of hazardous materials. It is imperative to avoid areas of landslide and lateral spread. The presence of any potentially liquefiable materials in foundation or backfill areas should be fully analyzed and expected settlements computed.

#### **2-4.3.4 Pipelines.**

Design pipelines to resist the expected earthquake induced deformations and stresses. In general, permissible tensile strains are on the order of 1 to 2 percent for modern steel pipe. To accommodate differential motion between pipelines and storage tanks, it is recommended that a length of pipeline greater than 15 pipe diameters extend radially from the tank before allowing bends and anchorage and that subsequent segments be of length not less than 15 diameters. Flexible couplings should be used on long pipelines. In general, pipes should not be fastened to differentially moving components;

rather, a pipe should move with the support structure without additional stress. Unbraced systems are subject to unpredictable sway whose amplitude is based on the system fundamental frequency, damping, and amplitude of excitation. For piping internal to a structure, bracing should be used for system components. Additional seismic protection considerations are as follows.

- In potentially active seismic areas, no section of pipe should be held fixed while an adjoining section is free to move, without provisions being made to relieve strains resulting from differential movement unless the pipe is shown to have sufficient stress capacity.
- Flexible connections should be used between valves and lines for valve installation on pipes 3 in (76 mm) or larger in diameter.
- Flexibility should be provided by use of flexible joints or couplings on a buried pipe passing through different soils with widely different degrees of consolidation immediately adjacent to both sides of the surface separating the different soils.
- Flexibility should be provided by use of flexible joints or couplings at all points that can be considered to act as anchors, at all points of abrupt change in direction, and at all tees.
- Piping containing hazardous materials should contain numerous shutoff valves and check valves to minimize release of materials if there is a break. Seismic shutoff valves should be used where necessary to control a system or process. A secondary containment system should be incorporated where feasible.
- When piping is connected to equipment or tanks, use of braided flexible hoses is preferable to bellow-type flexible connectors. Bellow-type flexible connectors have been noted to fail from metal fatigue. Welded joints are preferable to threaded or flanged joints. If flanged joints cannot be avoided, the use of self-energizing or spiral wound gaskets can allow a bolt to relax while continuing to provide a seal. (Reference: Association of Bay Area Governments, 1990.)

#### **2-4.3.5 Supports.**

Piers may contain pipelines for freshwater, saltwater, steam, compressed air, waste oil, sewer, and fuels systems; and may also contain electrical power and communication lines. Ship demands dictate the utility system configurations. In general, design of these lines follows the general provisions discussed herein. It is essential that the lines be attached to the supporting structure with sufficient rigidity that the lines are restrained against independent movement. Attachments to a pier may be analyzed as simple two-degree-of-freedom systems. Resonance amplification can occur when the natural period of the supported pipe is close to the fundamental period of the pier structure.

Flexible connections/sections should be used to bridge across expansion joints or other locations where needed.

#### **2-4.4 Cathodic Protection Systems (CPS).**

Provide special and detailed considerations for cathodic protection systems (CPS). This applies to pierside utility systems and the associated landside utility systems. Specific details are required for storage structures and the interface transition between the landside systems and the pierside systems. The services of a qualified corrosion engineer must be provided unless defined otherwise by the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. \4\ For additional information and requirements see UFC 3-570-02N /4/ , *Electrical Engineering, Cathodic Protection*, and guide specifications: UFGS 26 42 13.00 20, *Cathodic Protection By Galvanic Anodes*; UFGS 26 42 17.00 10, *Cathodic Protection System (Impressed Current)*; and UFGS 26 42 15.00 10, *Cathodic Protection System (Steel Water Tanks)*. /4/ Specific requirements are as follows:

- Provide CPS and protective coatings for the following buried or submerged metallic utility systems regardless of soil or water corrosivity:
  - 1) Petroleum, Oil and Lubricant (POL) pipelines.
  - 2) Oxygen pipelines.
  - 3) Underground POL and gasoline storage tanks.
  - 4) Underground hazardous substance storage tanks.
  - 5) All water storage tanks interiors.
  - 6) Other system's defined by the NAVFAC \4\ FEC /4/ OR USACE DISTRICT's Corrosion Control Coordinator.
- Provide a CPS and bonded protective coatings on other buried or submerged new steel, ductile iron, or cast iron utility pipelines not mentioned above when the resistivity is below 30,000 ohms at the installation depth at any point along the installation. Do not use unbonded protective coatings such as loose polyethylene wraps. Provide joint bonding on all ductile iron and cast iron installations.
- When an existing CPS is being modified or extended, the new CPS must be compatible with the existing CPS system. When plastic pipe is selected to replace or extend existing metallic pipe, thermal weld an insulated No. 8 AWG copper wire to the existing pipe and run the full length of the plastic pipe for continuity and locator tracing purposes.
- The CPS must provide protective potentials according to the requirements of the National Association of Corrosion Engineer (NACE) Standard

RP0169 (latest revision), *Control of External Corrosion on Underground or Submerged Metallic Piping Systems* and NACE Standard RP0285 (latest revision), *Standard Recommended Practice – Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*.

- Unless instructed otherwise by the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT, provide an engineering life-cycle cost (LCC) analysis for the CPS. Coordinate with the NAVFAC \4\ FEC /4/ OR USACE DISTRICT's Corrosion Control Coordinator to establish design efforts and field test efforts. Obtain preliminary approval from the Corrosion Control Coordinator prior to accomplishing the LCC analysis. Define the proposed elements of the LCC analysis and a general description of the proposed CPS design.
- Unless instructed otherwise, Architect-Engineer (A-E) CPS surveys and designs must be accomplished under the supervision of one of the following individuals:
  - 1) Registered Professional Corrosion Engineer.
  - 2) Registered Professional Engineer who is also a NACE certified corrosion protection specialist or cathodic protection specialist or has a minimum of five years of experience in the applicable CPS.
  - 3) NACE certified corrosion protection specialist or cathodic protection specialist with a minimum of five years experience in the applicable CPS.
- Unless instructed otherwise by the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT, perform field tests (resistivity, pH, current requirements, etc.) at the proposed installation to evaluate, as a minimum, soil and/or water corrosivity. The tests are used to design the CPS and assumptions must be supported by the field test data. Design the CPS for overall system maintainability.
- Project Managers must contact the NAVFAC \4\ FEC /4/ OR USACE DISTRICT's Corrosion Control Coordinator regarding the CPS design and, upon request, will forward the design documents to the Coordinator for review. Design submittals must include, as a minimum, the following:
  - 1) Preliminary Engineering Plan (PEP): soil and/or water corrosivity data, current requirements test data (if applicable), and all design calculations.
  - 2) Final drawings: the CPS one-line diagrams, locations of all cathodic protection equipment (anodes, rectifiers, test stations,

etc.), interference test points, installation details, insulating fittings, and bond connections.

- 3) Final specifications: acceptance testing procedures including static (native) potentials, initial and final system potentials, and interference tests.

## **2-5 METERING.**

In general, all utilities should be metered unless instructed otherwise by the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Metering actual utility usage provides accurate data for billing and historical purposes. Install meters in accessible vaults or in above-grade enclosures ashore or on piers. Specify state-of-the-art electronic meters unless instructed otherwise. Consult with the Activity to determine if there is an existing metering program and integrate new meters into such existing programs. Where metering is not initially provided, then include provisions for the easy future addition of meters. This may include providing concrete meter vaults or access covers in pipe trenches. Consult with the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for specific instructions.

## **2-6 PAINT AND FINISH REQUIREMENTS.**

Evaluate the requirements for paint and finish systems. Final requirements will be based upon geographical location, the respective utility system, Station standards and preferences, and the guidance defined in \4\ UFC 3-190-06, *Protective Coatings and Paints*. /4/ The designer must confer with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Final designs must be based upon the paint manufacturers's written instructions, especially with respect to surface preparation and paint/finish application.

## **2-7 UTILITY CONNECTIONS COLOR CODES.**

To ensure safety, shore-to-ship utility service connections use the standardized federal color codes as an identification system on wharf and pierside connections and hose assemblies. The primary identifiers should be plain language tags, nameplates, or labels. Special emphasis should be applied to potable water, nonpotable water and the sewer system. The color code system is defined in Chapter 6.

## **2-8 DEPERMING PIERS AND FACILITIES.**

Deperming piers and magnetic silencing facilities require special design consideration because of the magnetic operations. As a result, non-magnetic piping and conduit materials are required. This includes materials such as PVC, fiberglass and aluminum.

## CHAPTER 3 ACTIVE AND REPAIR BERTHING

### 3-1 STEAM SYSTEMS.

Provide steam service at 150 psi (1034 kPa) (saturated) along all piers and other waterfront structures used for active berthing and ship repair, and at the perimeter of graving drydocks. Provide 125 psi (862 kPa) only if approved by the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Laundries on many vessels use the highest pressure at 100 psi (689 kPa). Provisions for returning condensate from ships will not be required except in special cases, and as directed by the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Newer ships do not require steam services. Contact NAVFAC \4\4/ OR USACE to waive the mandatory steam requirement.

#### 3-1.1 Demands.

Steam requirements for selected ship classes are given in Appendix C. Generally, steam demand is considerably less in port than at sea. Loads must be selected for the appropriate local climate as indicated in Table 3-1. For ships not included in Appendix C, use data from a similar ship, or obtain the expected demand from NAVFAC \4\4/ or USACE. For graving drydocks, refer to UFC 4-213-10.

#### 3-1.2 Size of Piping.

Size the piping for single berths to meet the demands indicated. Include nested ships that are indicated on berthing plans. For multiple berthing, use diversity factors determined from Table 3-1. Branch steam lines from main to outlet locations should be sized for the full demands and should be no smaller than the outlet riser pipe. For ships that require two connection locations, assume 75 percent of the demand for sizing each branch. Refer to paragraph 3-1.5 for minimum outlet and riser sizes. Determination of pipe sizes should be in accordance with \4\ UFC 3-430-09, *Exterior Mechanical Utility Distribution.*\4/

#### 3-1.3 Piping System Design Criteria.

For steam piping and condensate return piping design requirements, refer to \4\ UFC 3-430-09 /4/ subject to the following exceptions and additions. It is noted that steam piping on piers and wharves is often specified to be ASTM A 53 steel.

##### 3-1.3.1 Pitch.

For steam piping on or under a pier, the pitch of piping required by \4\ UFC 3-430-09 /4/ may be impractical due to elevation limitations or structural interference. In such cases, the designer must compensate by proper sizing of piping and by provision for adequate condensate removal. Tidal submergence of piping should be avoided by whatever means are practical.

**Table 3-1 Diversity Factors (DF) for Steam Usage<sup>1</sup>**

Ship Type	Outdoor Temperature Range (degrees F)	Diversity Factor (DF) <sup>2</sup> for:			
		1 Ship	3 Ships	5 Ships	9 Ships
Surface Combatants	0 - 20	1	0.97	0.96	0.94
	20 - 40	1	0.93	0.89	0.86
	40 - 60	1	0.86	0.80	0.76
	> 60	1	0.80	0.73	0.68
Aircraft Carriers	0 - 20	1	0.97	0.96	0.95
	20 - 40	1	0.96	0.94	0.91
	40 - 60	1	0.93	0.90	0.86
	> 60	1	0.82	0.76	0.74
Amphibious	0 - 20	1	0.95	0.96	0.95
	20 - 40	1	0.87	0.94	0.91
	40 - 60	1	0.80	0.90	0.86
	> 60	1	0.78	0.76	0.74
Auxiliary	0 - 60	1	0.91	0.87	0.84
Aggregate	0 - 20	1	0.96	0.93	0.92
	20 - 40	1	0.93	0.90	0.88
	40 - 60	1	0.90	0.86	0.83
	> 60	1	0.86	0.81	0.78

1. Use of Diversity Factors (DF):

If the total number of ships in aggregate is greater than nine:

- Group the ships by types.
- Determine the maximum demand of each ship from the utility data. (See Part A.)
- Sum the individual demands within each type of ship.
- Multiply the total demand of each ship type by the appropriate DF, relative to the number of ships and temperature range.
- Total the demands obtained for the different ship type groups.

If the total number of ships in aggregate is nine or less:

- Determine the maximum demand for each ship from the utility data.
- Sum the individual demands of each ship.
- Obtain the aggregate DF from Table 3-1.
- Multiply the total demand by the "aggregate" DF in Table 3-1.

2. Linear interpolation is permissible for actual ship quantities.

**Table 3-1 (Continued) Shore Services –Steam Table<sup>1 2 3</sup>**

Ship Type	Class	(a) Intermittent Heating Loads <sup>4</sup> (lb/hr) for Outdoor Temperatures of				(b) Constant Load <sup>5</sup> (lb/hr)	Ships Connection Data <sup>6</sup>			
		10°F	30°F	50°F	70°F		L	H	N	
		<u>Surface Combatants</u>								
Cruiser	CG-47	9,100					328S			
						335P				
Destroyer	DD-963	2,100	1,400	900	550	900	293S	26	1	
							339P		1	
	DDG-51 <sup>7</sup>									
Frigate	FFG-7						318S	35	1	

NOTES TO TABLE 3-1

1. Loads based on ship's peacetime complement (no air wing or troops). Refer to text when allowance must be made for these items.
2. Maximum single ship demand at shore connections is column (a) plus column (b).
3. For multiple ships, see Diversity Factors included Table 3-1.
4. Steam quantity required to achieve normal environmental temperature in ship spaces relative to the outdoor temperatures shown. Interpolation between temperature columns is permissible. Determine specific site design temperature from \4\ UFC 3-400-02, *Design: Engineering Weather Data*, 99 percent /4/ basis, whenever available. Design temperatures for sites not listed may be obtained from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., *ASHRAE Handbook*, 97-1/2 percent basis.
5. Galley, laundry, hot water, etc.
6. Land H refers to the location of connections on ships. L is the distance (in feet) of the connection aft of the point of stem of the ship and H is the height (in feet) of the connection above the design waterline. Designations "P" and "S" refer to port side and starboard side, respectively. Where more than one connection exists, all locations are shown. The designation "N" refers to the number of shipboard hose connections at the given locations.
7. Steam not required.

**3-1.3.2 Protection.**

For steam and condensate piping under a pier or wharf, or in a drydock where submergence may occur, piping should be encased in a pressure-testable, prefabricated conduit system. Corrosion-resistant conduit coatings should be selected, and polyethylene heat-shrinkable sleeves and/or high temperature tape wrapping must be used at joints and fittings. Provide pipe hangers and associated support assemblies in accordance with paragraph 2-4.1.3. Hangers should be designed based upon the maximum potential weight of the steam system; that is, the piping is full of water. Identify piping and outlets and color-code in accordance with Chapter 6.

**3-1.4 Location and Arrangement of Piping Mains and Branches.**

As a general rule for all active berthing piers, provide a single main with cross-branch piping to outlets. For repair piers, provide a main on each side of the pier and a cross connection at the outboard end of the pier. Coordinate piping with structural conditions and arrange mains for the best combination of versatility, security, and overall cost. It is normally more desirable operationally to provide a looped main rather than an equivalent single main. Provide isolation valves at appropriate locations for reliability of service during emergency repairs. For graving drydocks, refer to UFC 4-213-10. The location of ships steam connections may be found in Appendix C. For discussion of methods to be used to establish shore utility-station spacing on piers and wharves, refer to Chapter 2.

**3-1.5 Outlet Design.**

See Figure 3-1. Naval facilities use 2 in (50.8 mm) hoses (from 1 to 10 per ship) almost exclusively for ship-to-shore steam connections. At locations where 1-1/2 in (38.1 mm) and 1 in (25.4 mm) hoses are used, design for 2 in (50.8 mm) hoses and utilize reducing fittings at hose connections. Total numbers of shipboard steam connections are found in Appendix C. The number of hoses actually connected to shore per ship varies with the severity of the climate. For facilities in the coldest climates (see Appendix C, Figure C-1, Regions I and II), assume that all ships connections will be connected to shore. For warmer climates, obtain the demand for the appropriate design temperature; divide by 2500 for 2 in (50.8 mm) hose and by 1250 for 1-1/2 in (38.1 mm) hose. For existing facilities, the maximum number of hose connections actually made for the ships to be berthed may be obtained from the cognizant NAVFAC 141 FEC /4/ OR USACE DISTRICT. Refer to Chapter 2 for a general description of the arrangement and spacing of utility outlets.

**3-1.5.1 Steam Outlet Assemblies.**

The design of steam outlet assemblies is to include the following conditions.

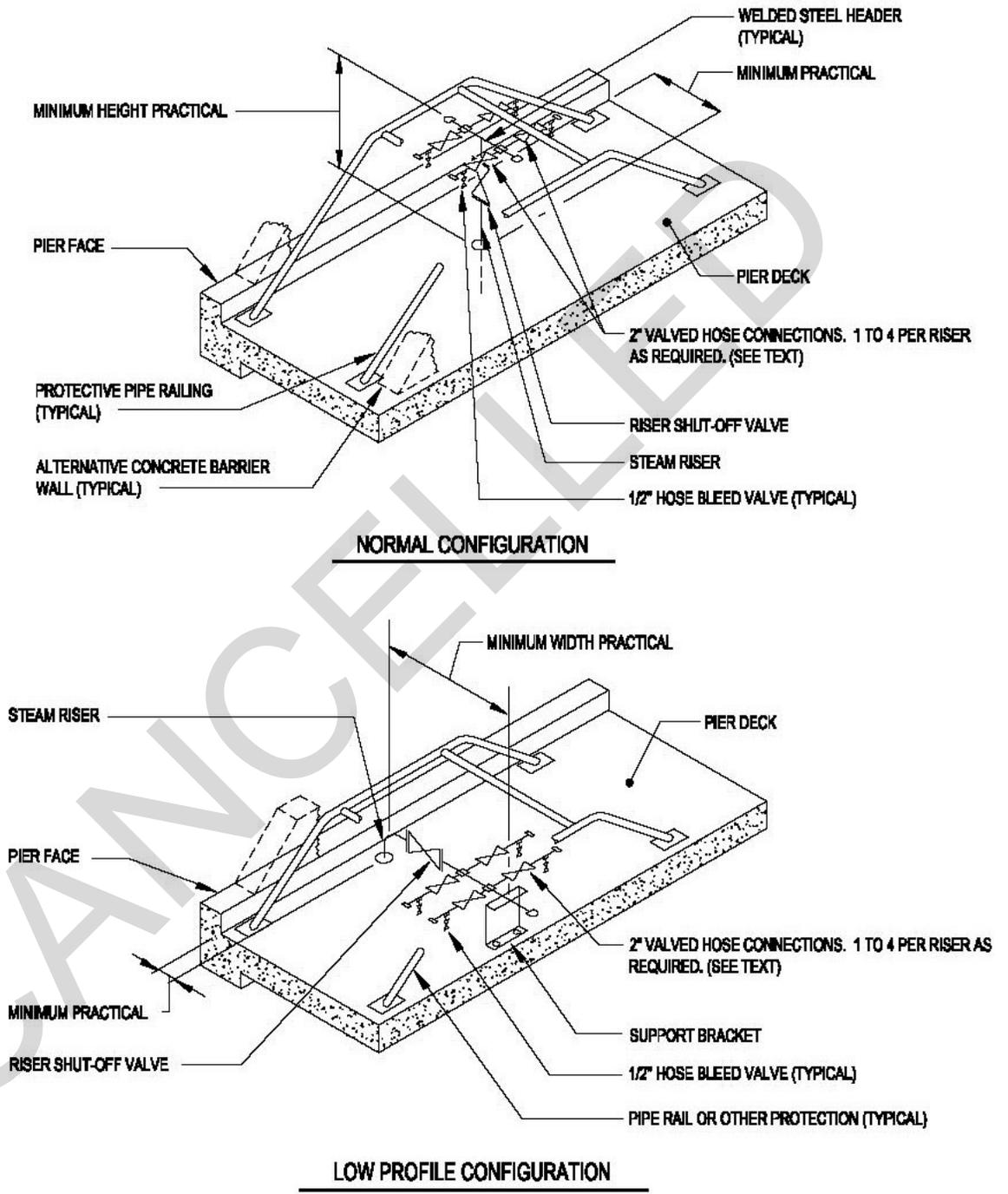
- Provide a shut-off valve for each riser assembly. The valve must be easily accessible.
- Provide a welded steel header after the riser shut-off valve. The header must serve the hose connections.

- The designer is responsible for determining the number of hose connections required at each outlet assembly.
- Hose connections must be 2 in (50.8 mm) unless instructed otherwise.
- Each hose connection must include a shut-off valve, a 1/2 in (12.7 mm) hose bleeder valve, and a hose connector. Threaded connections are to be avoided in order to prevent loosening of joints due to hose tension.
- Minimum pipe size of each rise assembly must be as follows:

<u>NUMBER OF HOSES CONNECTED TO RISER</u>	<u>RISER SIZE INCHES ( MM)</u>
1	2-1/2 in (63.5 mm)
2	3 in (76.2 mm)
3 or 4	4 in (101.6 mm)

CANCELLED

Figure 3-1 Typical Steam Outlet Assembly



### **3-1.6 Specific Ship Requirements**

#### **3-1.6.1 CV and CVN Ship Requirements (All Classes).**

These ships are normally berthed starboard side-to. Steam is provided to CVNs certified pure at 150 psi (1034 kPa). Galley and hot water requirements should be increased by 50 percent where it is reasonable to assume that the ship's air wing may be on board.

#### **3-1.6.2 Nuclear-Powered Submarine Requirements.**

Steam supply for nuclear-powered submarines is not required at operational berths. For ship construction or major repair activities, high-pressure steam at 2000 to 4000 psi (13.8 to 27.6 MPa) may be required for test purposes. This supply may be from a permanent plant or from a portable steam generator. The proper selection is dependent upon local weather conditions. Evaluate each location on an individual basis. The cognizant NAVFAC 141 FEC /4 OR USACE DISTRICT will approve.

#### **3-1.6.3 Troop Carrier Special Requirements (LHA, LHD, LPD, LSD, and LST).**

Provide steam service at 150 psi (1034 kPa) certified pure. For LHA, LHD, LPD, and LSD increase galley and hot water requirements by 100 percent if it is probable that troops will be aboard while at active berths.

#### **3-1.6.4 Nested Ships.**

Maximum nested ships demand at shore connections is 17,950 pph (8142 kg/h) based on the requirements of nested CG-47s.

### **3-1.7 Shore-to-Ship Steam and Feedwater Requirements**

#### **3-1.7.1 Quality.**

Naval Sea Systems Command (NAVSEA) shore-to-ship steam and feedwater quality standards are provided in NAVSEA S9086-AB-ROM-010, Naval Ship's Technical Manual (NSTM), Chapter 220, *Boiler Water/Feedwater - Test and Treatment*, paragraphs entitled: "Shore Steam and Condensed Shore Steam Used as Feedwater"; "Navy and Commercial Facility Shore Steam Certification Requirements"; "Shore Processed Feedwater (Demineralizers, Reverse Osmosis)"; "Shore Source Feedwater Requirements"; and "Makeup Feedwater Demineralizer System". These standards are given in Table 3-2 and Table 3-3.

**Table 3-2 Shore Steam and Condensed Shore Steam Quality Requirements<sup>1 2</sup>**

<u>CONSTITUENT OR PROPERTY</u>	<u>REQUIREMENT</u>
pH	8.0 to 9.5
Conductivity	25 [ $\mu$ ]S/cm maximum <sup>2</sup>
Dissolved Silica	0.2 ppm maximum
Hardness	0.10 ppm max or 5 ppm as CaCO <sub>3</sub> total hardness
Total Suspended Solids	0.10 ppm maximum

1. Steam must be generated from feedwater which is either treated with a chemical oxygen scavenger or mechanically deaerated to a maximum dissolved oxygen content of 15 parts per billion. Shore steam and condensed shore steam used as feedwater must meet the above standards. The use of filming amines is prohibited.
2. [ $\mu$ ]S/cm = micro-Siemens/centimeter = micro-mho/centimeter. The lowest reading on the shipboard conductivity meter is 40.

**Table 3-3 Bulk Shore Feedwater Quality Requirements<sup>1</sup>**

<u>CONSTITUENT OR PROPERTY</u>	<u>REQUIREMENT</u>
pH	5.4 to 8.2 (process effluent)
Conductivity	2.5 [ $\mu$ ]S/cm maximum (at point of delivery <sup>2</sup> )
Silica	0.2 ppm maximum

1. Produced by method other than condensed steam.
2. [ $\mu$ ]S/cm = micro-Siemens/centimeter = micro-mho/centimeter.

### **3-1.7.2 Use of Steam Separators.**

Provide steam separators as required to meet the NAVSEA criteria for the purity of shore-to-ship steam in Navy ports. Properly selected steam separators may be installed in steam mains at piers, wharves, and drydocks. (See S9086-AB-ROM-010 NSTM Chapter 220.) These will provide additional protection against condensate carryover and the resultant steam contamination where such problems are known to exist. Normally, steam separators are not required on piers, wharves, or drydocks if adequate condensate removal is provided at the boiler plant and in shore mains. Steam separators should be used only when necessary and as based upon a case-by-case evaluation of local conditions. If a steam separator should be necessary, then Figure 3-2 provides a typical installation detail that should be used in conjunction with the guidelines of NFESC Test Report No. TN-1586, *Steam Separator Test and Evaluation*.

### **3-1.7.3 Sampling.**

Due to the harsh marine environment, conductivity and pH meters should not be installed permanently on piers or wharves. Condensate sampling stations should be provided at piers and at steam plants. Figure 3-2 also shows a typical installation of a sampling station.

### **3-1.8 Metering.**

Where monitoring of usage is required, provide metering of steam flows to piers, groups of piers, or drydocks. Install meters in accessible vaults or in above grade enclosures ashore or on piers. At individual piers or drydocks, use pressure and/or temperature compensated electronic microprocessor type flow meters for good mass flow accuracy and range. Consult with the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT to determine if a steam meter installation and maintenance program exists at the Activity. Consult the Activity steam meter program coordinator to integrate the flow meter type selection into any existing meter program. Where metering is not initially required, make provision for ease of future installation by means of concrete vaults or pier access covers.

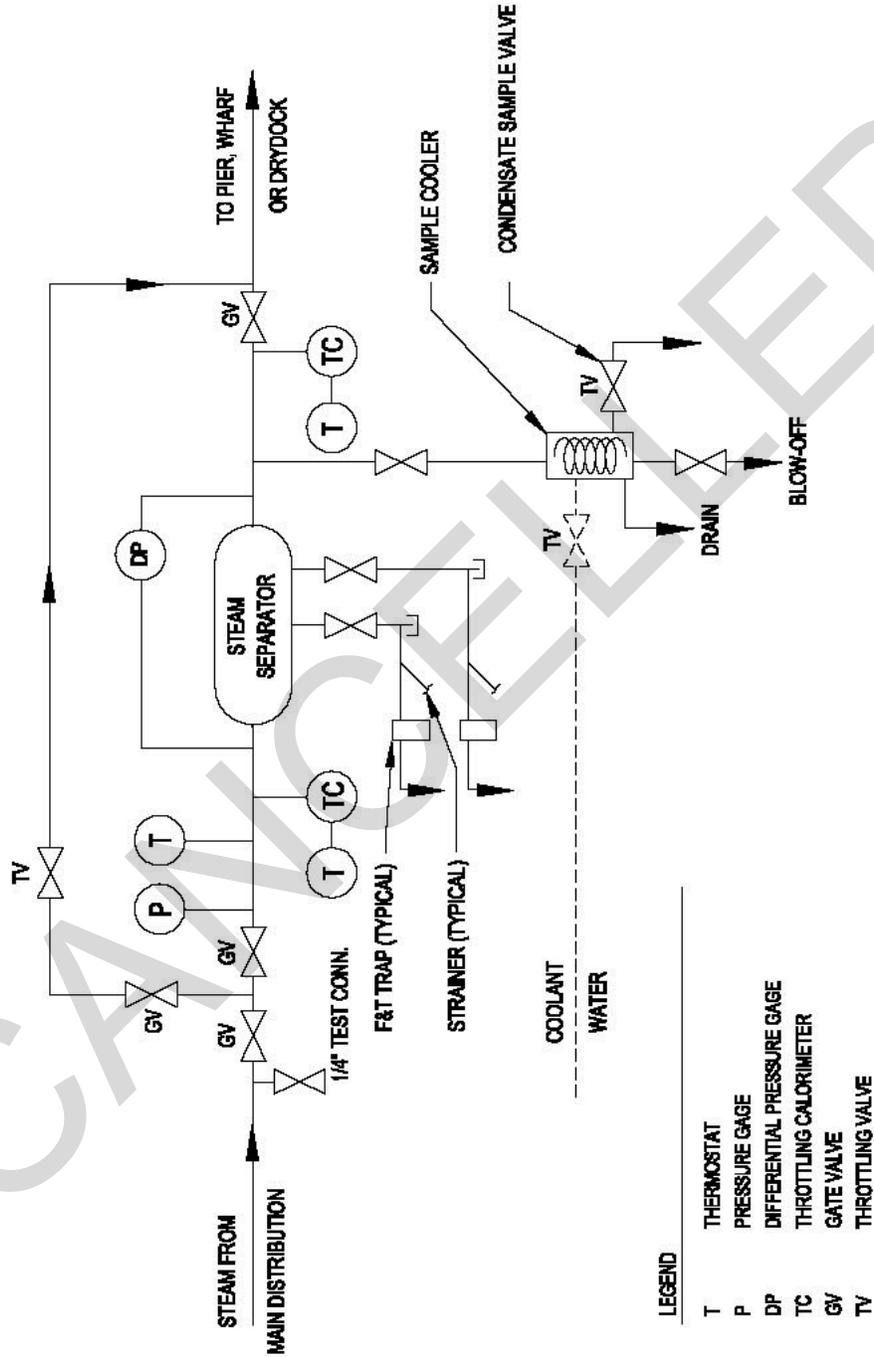
## **3-2 COMPRESSED AIR SYSTEMS.**

In general, a compressed air system is required at all active and repair berths. However, final needs and requirements vary on a pier-by-pier basis. Consult with the Activity for actual requirements, existing construction standards, and preferences. Requirements for graving drydocks are given in UFC 4-213-10.

### **3-2.1 Demands.**

Compressed air requirements for selected ship classes are defined in Appendix C. For ships not included in Appendix C use data from a similar ship, or obtain the expected demand from NAVFAC \4\4/ or USACE.

Figure 3-2 Schematic Steam Separator and Sampling Station



**3-2.2 Piping System Design Criteria.**

Design compressed air piping to conform to commercially available standard practices. Also, the designer may consult \4\ UFC 3-430-09 *Exterior Mechanical Utility Distribution* /4/. In addition, provide corrosion protection of steel pipes. Consider an extruded polyethylene or polypropylene exterior coating. Extruded plastic coatings must contain an ultraviolet inhibitor. For coated pipe, use polyethylene, heat-shrinkable sleeves and/or tape wrapping at joints and fittings. Provide pipe hangers and associated support assemblies in accordance with paragraph 2-4.1.3. Identify piping and outlets and color-code in accordance with Chapter 6.

**3-2.3 Quality.**

Compressed air should normally be "commercial" quality. Where breathing quality air and/or an oil-free system is necessary use an oil-free source and/or purification systems. Compressed breathing air compressors must meet the requirements of 29 CFR 1910.134 and the requirements for Grade D breathing air described in CGA G-7.1, *Commodity Specification for Air*. Locate compressors used to supply breathing air so as to prevent entry of contaminated air into the air supply system and breathing air couplings are incompatible with outlets for nonrespirable worksite air or other gas systems.

**3-2.4 Size of Piping.**

For single berths, size the mains in accordance with air quantity per ship data given in Appendix C. Multiple pier demand data for use in design of new compressed air plants and at new facilities should be obtained by evaluating demands at operating Naval berthing and repair facilities which are similar to the proposed facility. The designer should consult with the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. For multiple berthing at a single pier or wharf, including nested ships, use the following diversity factors:

<u>NUMBER OF SHIPS</u>	<u>DIVERSITY FACTOR</u>
1	1.0
2	0.8
3	0.7
4	0.6
5 or more	0.5

**3-2.4.1 Branches.**

Branch-pipe sizes should be in accordance with the ships' usage data defined in Appendix C. Where a variable mixture of ships is probable at a given pier, all branch lines should be 3 in (76.2 mm) minimum. However, where carriers may be berthed, branch lines should be 4 in (101.6 mm) minimum.

**3-2.4.2 Sizing Method.**

Determination of pipe size should be in accordance with available friction loss tables. Size mains for a pressure drop of not greater than 5 psi (34.47 kPa) total friction loss

from pier or wharf entrance to farthest outlet, and as based upon the designed flow rates. For looped mains, assume flow in both legs of the loop. In all cases, mains should be sized to supply the most outboard ship with 100 percent of the quantity defined in Appendix C, and then adjusted for its full-diversified demand.

**3-2.5 Location and Arrangement of Piping Mains and Branches.**

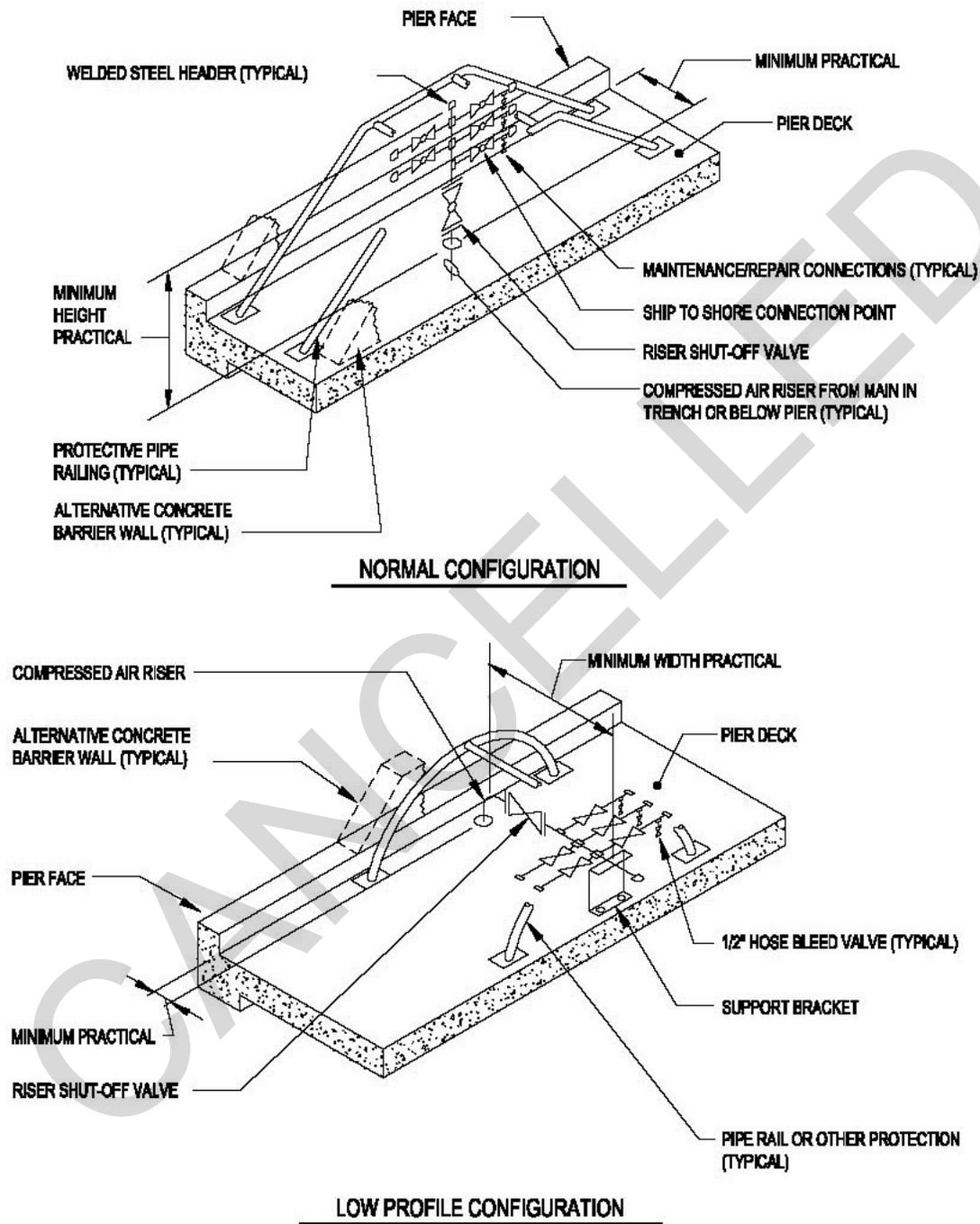
As a general rule, provide a single compressed air main with cross branch piping to outlets for all active berthing piers and for all repair piers 50 ft (15.24 m) or less in width. For repair piers wider than 50 ft (15.24 m), provide a piping main on both sides of the pier and provide a cross connection at the outboard end of the pier (loop configuration). Coordinate piping with structural conditions and arrange mains for the best combination of versatility, security, and overall cost. It is normally more desirable operationally to provide a looped compressed air main rather than an equivalent single main. Provide isolation valves at appropriate locations for reliability of service during emergency repairs. The number of shore compressed air outlets and risers for various ship types is defined in Appendix C. Specific ships connection locations (one or two per ship) are also defined. However, compressed air may be required at many locations both on and alongside a ship during maintenance or repair operations. The number of outlets and risers per berth should therefore be integrated within utility groups designed and spaced as discussed in Chapter 2.

**3-2.6 Outlet Design.**

See Figure 3-3. The size of outlet risers should be the same as that of branch piping. Provide a full-sized accessible shut-off valve in each branch near the outlet riser. Hose couplers for maintenance and repair connections should be quick coupler type and must match those used by the Activity. When the site is an existing facility, the number and size of maintenance and repair hose connections required to match a facility standard may be used in lieu of those given in the following table. Shore couplings for 2-1/2 in (63.5 mm) ship-to-shore connections should be male cam-locking connector with cap which complies with Commercial Item Description (CID) A-A-59326, *Coupling Halves, Quick-Disconnect, Cam-Locking Type* (with supplements). Shore couplings for 4 in (101.6 mm) ship-to-shore connections should be 150-pound flanges with blind flange covers. Refer to Chapter 2 for general description of the arrangement and spacing of utility outlets. Provide a header at the outlet riser, with hose connections (valved outlets and hose couplers) sized as follows:

<u>SIZE OF RISER</u>	<u>MAINTENANCE AND REPAIR CONNECTIONS</u>	<u>SHIP-TO-SHORE CONNECTION</u>
2 inch	Four 3/4 inch	None
3 inch	Two 3/4 inch & Two 1-3/4 inch	4 inch
4 inch	Two 3/4 inch & Two 1-1/4 inch	4 inch

Figure 3-3 Typical Compressed Air Outlet Assembly



### **3-2.7 Requirements for High-Pressure Compressed Air.**

Many submarines require a high-pressure compressed-air supply in addition to the customary compressed-air requirements. CVN-68 class also requires high pressure air (ref NSTM Chapter 9490). This service may be provided by tapping an available 3000 psi (20.7 MPa) or 4500 psi (31.0 MPa) source, or by utilizing portable compressors. Required ships service size is normally 1/2 in (12.7 mm) or 3/4 in (19.05 mm). The ship's compressors will be used for tophoff under emergency conditions. Air quality should be in accordance with NAVSEA S9086-AB-ROM-010, *Naval Ship's Technical Manual* (NSTM), Chapter 551, *Compressed Air Plants and Systems*. This chapter requires air to be oil free and dehumidified by a desiccant type dehydrator to a dew point (at atmospheric pressure) of -60 degrees F (-51 degrees C). High-pressure compressed air service is normally portable and provided by the Activity, but the need must be determined on an individual site basis.

### **3-3 SALTWATER OR NONPOTABLE WATER SYSTEMS.**

Shore-supplied saltwater or nonpotable water must not be provided to active berthing piers and wharves unless instructed otherwise. However, there are existing piers and wharves that use saltwater or nonpotable water to meet ship fire protection, cooling, and flushing requirements. For drydocks, refer to UFC 4-213-10. For pier and wharf fire protection requirements, refer to UFC 3-600-01 *Fire Protection Engineering for Facilities*, as well as the criteria in this UFC. Consult with the cognizant fire protection engineer, both at the local level and at the NAVFAC \4\ FEC /4/ OR USACE DISTRICT level.

#### **3-3.1 Justification.**

The use of permanent salt or nonpotable water systems must be justified and approved in advance by NAVFAC \4\4/. Use the following criteria to establish approval requirements for these systems.

##### **3-3.1.1 Repair Piers and Drydocks.**

At facilities used for major ship repair in which the repaired ships do not have use of their own pumping capabilities, permanent shore salt or nonpotable water systems are normally utilized. These types of installations do not require prior approval. Design such systems in accordance with applicable requirements defined herein and beginning with paragraph 3-3.2.

##### **3-3.1.2 Active Berthing.**

Permanent salt or nonpotable water systems should not be provided at active berthing facilities unless instructed otherwise. It is the Navy's intent that ships at active berth will normally rely upon their own pumping capabilities to supply saltwater for flushing/cooling and firefighting. In the event of a major fire or other emergency, shore-based portable pumps and other available station fire apparatus would be utilized to augment the ship's saltwater pumping capability.

Generally, fixed fire protection systems are not required for active berthing piers when the level of the pier is low enough to the waterline such that the responding fire crews can perform drafting operations from the pier. However, with the development of the double-decker type piers, normal fire department operations are restricted due to the elevation of the pier above the water level. Provide dry standpipe systems for piers where construction features restrict fire department vehicle access and/or prevent the fire department from performing drafting evolutions from the pier. The system consists of multiple inlet, or pumper, connections and multiple outlet (standpipe) connections located on both levels of the pier.

Locate inlet connections on both sides of the access ramp and size to support flows of 3,000 gpm (190 l/sec). Pumper connection type should be as preferred by the base fire department, but typically will consist of both 5 in (127 mm) Stortz and 2-1/2 in (63.5 mm) connections. This configuration will permit the fire department to obtain water from adjacent fire hydrants, drafting operations from the relieving platform, or a combination of both.

Outlet connections consist of the following:

- Upper level connections consist of a single 5 in (127 mm) Stortz outlet and valve or (4) 2-1/2 in (63.5 mm) hose valves. Locate connections at each stair access point to the lower level and at the top of the pier access ramp.
- Lower level standpipe or hose stations consist of (2) 2-1/2 in (63.5 mm) hose valves. Locate hose stations along both sides of the pier, spaced so that all portions of the lower level are within 150-ft (45 m) of a hose connection. Measure distances along a path of travel originating at the hose connection.

Identify locations of the lower level connections on the upper level by color coordinated reflective markers located on the curb along the pier edge. Provide reflective markers to identify all fire protection and ship service connections. Identify locations of lower level connections on the lower level by painting the adjacent pier structural column (bent) red in color.

Main distribution piping on the pier must be a minimum 8-inch (203 mm) diameter, Schedule 40-Galvanized. Loop piping to supply hose stations along both sides. Piping must not infringe on vehicle lanes with respect to clear height requirements.

### **3-3.1.3 Justification Requirements.**

At locations where special conditions or hazards exist, permanent salt or nonpotable water systems will be allowed for active berthing and inactive berthing facilities on a case-by-case basis provided: (1) it is adequately justified by the Activity; and (2) it is approved in advance by the NAVFAC or USACE Chief Fire Protection Engineer. Each pier or wharf at a given facility must be considered separately unless the usage of two

or more piers is identical. The Station/Activity should submit the following when requesting approval for these systems.

- Identify the type of facility and activities, and describe the special condition(s) or hazard(s) peculiar to this facility upon which this request is based.
- Establish the required pier or facility demand and pressure parameters based on the methods given in paragraph 3-3.2.
- Provide description and analysis of the options available to provide the required protection such as: (1) permanent system to supply the entire demand; (2) portable pumping systems(s) dedicated or otherwise; and (3) combinations of items (1) and (2). All existing Navy assets must be included in the analysis including any existing permanent systems.
- Provide a life cycle cost analysis for all viable options on a site-specific basis. Perform the analysis in accordance with NAVFAC P-442, *Economic Analysis Handbook*. The analysis must take into consideration the costs of owning and operating all pertinent plants, both on ships and ashore.
- Make recommendations for the best system to meet the required demand as based on consideration of the special conditions(s) or hazards(s) and on the life cycle cost analysis.
- The demands and pressure parameters of an approved permanent salt or nonpotable water system should be designed as described in paragraph 3-3.2 and all subparagraphs.

### **3-3.2 Demands and Pressure Requirements.**

Berthing facilities should conform to the requirements specified below. Note that the requirements differ for overhaul and drydock berthing versus those for active berthing.

#### **3-3.2.1 Drydock, Repair and Inactive Berthing.**

Nonpotable or saltwater supply should be furnished at drydocks, piers, and wharves as described below. Requirements for selected ship classes are defined in Appendix C. For ships not included in Appendix C, use data from a similar ship, or obtain the expected demand from NAVFAC 14V4/. The following criteria should also apply.

- Drydock. Provide sufficient saltwater to meet the requirement of the ship with the highest saltwater demand anticipated to be docked at the drydock. Use the "Total Demand" quantity listed in Appendix C. Refer to UFC 4-213-10 for additional requirements at drydocks.
- Repair Berthing. Provide sufficient saltwater to meet the "Total Demand" requirement defined in Appendix C for the largest ship to be berthed at the

pier plus the aggregate cooling/flushing demand of all remaining ships at the pier, and then multiplied by the diversity factors given below. In general, allow 1000 gpm (63 l/s) minimum for piers serving frigate ships and larger and 500 gpm (32 l/s) minimum for piers serving ships smaller than frigates. Also, do not include nested ships.

<u>NUMBER OF SHIPS</u>	<u>DIVERSITY FACTOR</u>
1	1.0
2	0.9
3	0.8
4	0.7
Over 4	0.6

- **Total System Demand.** Where a system serves more than one pier, assume only one ship fire will occur for the group of repair piers. The multiple pier supply system should be designed to meet the requirement of the pier with the highest demand plus the aggregate cooling/flushing demand from ships at all remaining piers, and then adjusted by the same diversity factors defined above. To obtain an overall demand that includes drydocks, add the sum of all drydock demands to the multiple pier demand as described herein.
- **Pressure Requirement.** The saltwater pressure should be 150 psi (1034 kPa) residual pressure (for all ships except submarines) at the most remote outlet. Submarines require only 40 psi (276 kPa). These pressure requirements should be available within 3 minutes of system activation.

**3-3.2.2 Active Berthing (Single or Multiple Berths).**

As stated previously in paragraph 3-3, shore supplied saltwater or non-potable water should not be provided to active berthing piers or wharves. However, there are instance where this occurs. In the criteria given below for saltwater or nonpotable water demands, one of the following conditions of flow governs. (Note: Either the fire protection demand or the cooling/flushing demand may govern. Use whichever is greater.)

- Base fire demand on a fire occurring aboard the ship with the largest fire protection demand plus the cooling/flushing ratings of all other ships connected to the fire protection water systems, and then adjusted for diversity.
- Base cooling/flushing demand on the aggregate of connected ships and then adjusted for diversity.

Requirements for selected ship classes are defined in Appendix C. For ships not included in Appendix C, use data from a similar ship, or obtain the expected demand from NAVFAC \4V4/. For CVN-68 class ship include saltwater for firefighting and

cooling/flushing when potential exists for ship to be in cold iron status. Total demand equals firefighting plus cooling/flushing flow.

### **3-3.3 Pumping Equipment.**

Pumps may be permanent, portable or mobile as justified and approved under the requirements defined in paragraph 3-3.1. In general, pump capacities and heads should be selected to provide for both fire protection and cooling/flushing requirements. Use separate pumps for the two requirements only when specifically allowed or when upgrading an existing system as defined in paragraph 3-3.5.2. Refer to UFC 3-600-01 for requirements of fire pumps and associated equipment. Centrifugal fire pumps should comply with NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*. /4/

#### **3-3.3.1 Drives.**

As defined by NFPA 20, fire pumps may be driven entirely by electric motors if either a single reliable power source is available, or if two independent power sources are available. Single reliable power sources need not include dual substations or starting equipment. If the above conditions for use of "electric drive only" cannot be met, design the system such that a minimum of 50 percent of pumping capacity is driven by approved alternative drives such as diesel engines. Portable or mobile pumping equipment is normally driven by remote-starting electric motors (when appropriate) or by diesel or gas-turbine engines.

#### **3-3.3.2 Pressure Control.**

Pressure must be controlled under varying demands by staging of pumps and by incorporation of surge tanks and/or other suitable equipment. It is imperative to prevent excessive surges due to starting and stopping of pumps. Use a small pressure-maintenance pump to handle low flows. Fire pumps must be equipped for automatic startup upon pressure drop, manual stop, and provision for "manual override startup".

#### **3-3.3.3 Alternative Pump Drive.**

When a separate cooling/flushing water system is used, a variable speed electric drive may be used to control pressure. Variable speed equipment may also be used for combined fire protection and cooling/flushing systems when approved by the cognizant NAVFAC /4/FEC /4/ OR USACE DISTRICT. Variable speed drive equipment should be selected from types that have been proven by successful use. Adjustable frequency type variable speed systems are preferred because of their higher efficiency. See /4/ UFC 3-520-01, *Interior Electrical Systems* /4/, for additional requirements regarding variable speed systems.

#### **3-3.3.4 Location.**

Permanent pumping equipment for individual piers, wharves, or drydocks should be located ashore and as near as possible to the pier, wharf or drydock. It is highly preferred to provide vertical pumps with wet sump/intake configuration. Where this is impractical, then the pumps may be placed in an enclosure on or alongside a pier or

wharf. The pump columns must be adequately protected from wave action and floating debris. Portable or mobile pumping equipment may also be placed on pier decks or on floating platforms moored to the pier.

**3-3.3.5 Materials.**

Care must be taken when specifying pump materials for nonpotable water service. Where salt or brackish waters are present, the potential for galvanic and crevice corrosion is severe. Steel and cast iron, ordinary brass and bronze, and most stainless steels are not suitable for these corrosive water sources. Specially coated steel and cast iron as well as 400 series stainless steel have proven to be ineffective. Material selection should be based on a thorough investigation of the site and operational conditions. The construction specifications should be explicit as to materials required for each major part, indicating appropriate ASTM designation and Unified Numbering System (UNS) number per *Metals and Alloys in the Unified Numbering System*. Since it is impractical to list all parts, a sentence such as the following should be included:

"Minor parts not listed should be of comparable materials with equivalent corrosion resistance to the materials listed."

Submittals for Government approval, including material lists, should be required for pumps. Materials generally considered appropriate for salt and brackish waters are as follows:

<u>APPLICATION</u>	<u>MATERIAL</u>	<u>ASTM</u>	<u>UNS</u>
All wetted parts	316 SS, or	A276*	S31600
	316L SS	A276*	S31603
Shafts/Couplings	Nickel-Copper (Monel)	B164*	N04400
		and B165*	N04400
All wetted parts, except shafts/cplgs	Alum Bronze, or Ni-Alum Bronze	B148*	C95200
		B148*	C95500

\* Full titles for ASTM Standards can be found in Appendix A.

In salt water it is important to avoid dissimilarity of parts. Pumps constructed of type 316L stainless steel or nickel aluminum bronze with monel shafts are preferred. In brackish water, cost savings can be realized by allowing acceptably small dissimilarities. Aluminum bronze pumps with type 316 stainless steel shafts are a reasonable alternative. The presence of sand/grit must also be considered. Pumps constructed of stainless steels handle sand/grit better than pumps constructed of bronze and other copper alloys. However, saline waters corrosion concerns are still paramount.

**3-3.4 Piping and Outlets**

**3-3.4.1 Size of Mains.**

Piping systems must be designed to provide the required residual pressure at the rated design flows to the berths farthest from the pumping location. Where a common shore pumping and distribution system feeds several piers or drydocks, the shore distribution system must be sized to deliver the design firefighting flow to any one of the piers or drydocks while cooling/flushing flows continue to all other locations.

#### **3-3.4.2 Location and Arrangement of Mains.**

As a general rule, when permanent mains are placed on piers 50 ft (15.24 m) or less in width, provide a single main with branch lateral pipes for outlets on both sides of the pier. For piers wider than 50 ft (15.24 m), provide a main on both sides of the pier with a cross connection at the outboard end of the pier (loop configuration). Coordinate piping with structural conditions and arrange mains for the best combination of versatility, security, and overall cost. It is normally more desirable operationally to provide a looped main than an equivalent single main. Provide isolation valves at appropriate locations for reliability of service during emergency repairs. Segregation valve should be placed in the fire main loop so that the maximum distance between any two adjoining valves does not exceed 200 ft (61 m).

#### **3-3.4.3 Location and Spacing of Outlets.**

The pier location of ships' saltwater connections are defined in Appendix C. Refer to Chapter 2 for a description of the methods to be used in establishing shore utility-station spacing on piers and wharves. Hose valve manifolds should be provided in sufficient numbers such that all parts of the ship can be reached by at least two 100 ft (30.5 m) hoses. For spacing in drydocks, refer to UFC 4-213-10.

#### **3-3.4.4 Outlet Design.**

See Figure 3-4. The typical outlet should consist of a 6 in (152.4 mm) branch main and riser feeding a manifold arrangement of three 2-1/2 in (63.5 mm) and one 4 in (101.6 mm) valved hose connections. Where portable pumping systems are used, standpipe connections may be provided on some (or each) of the outlet risers for connection to the portable pumping system discharge hose. For certain large ships, the above outlet requirements should be modified as defined in paragraph 3-3.5. Provide four 4 in (101.6 mm) valved hose connections in a manifold arrangement at the outboard end of large piers. These outlets are to serve fireboat or large-volume portable-pump connections. Where berthing is designed exclusively for tugboats, work boats, or other small craft having a "Salt Water From Shore" requirement of not more than 625 gpm (39.4 l/s), properly spaced 4 in (101.6 mm) risers having two to three 2-1/2 in (63.5 mm) connections may be used in lieu of the above. All connections should be protected by a chained cap. At each designated pier in each naval station where oceangoing U.S. merchant and foreign ships are expected, provide two international shore connections. See Figure 3-5.

#### **3-3.4.5 Materials and Installation Criteria.**

Pipe and fittings should conform to \4\ UFC 3-230-19N /4/, *Water Supply Systems*, as applicable to piers and wharves. Use pipe, fittings and valves pressure-rated at 250 psi

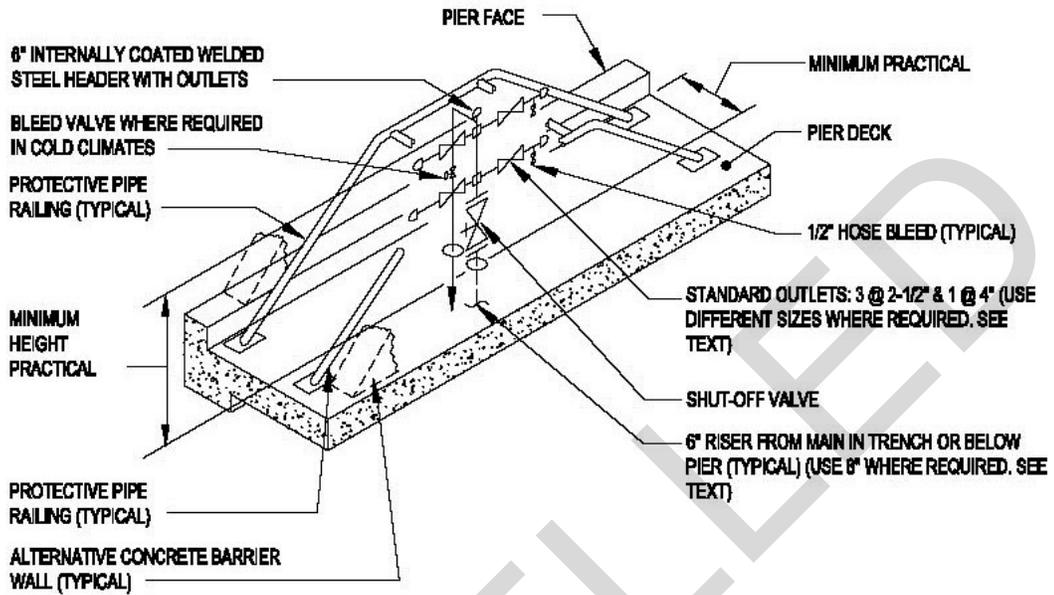
(1724 kPa) minimum. Hose threads should be National Standard hose-coupling threads, 7-1/2 threads/inch, or as approved by the cognizant Fire Protection Engineer. Materials for valves should conform to requirements for pumps as defined in paragraph 3-3.3.5. For piping on a pier or wharf, evaluate the relative advantages of cement-lined ductile iron versus cement-lined steel pipe with an extruded polyethylene or polypropylene exterior coating. An ultra violet inhibitor must be used in polyethylene coatings that will be exposed to sunlight. For coated pipe, use polyethylene heat-shrinkable sleeves and/or tape wrapping at joints and fittings. Provide pipe hangers and associated support assemblies in accordance with paragraph 2-4.1.3. Provide means of pipe movement due to thermal expansion, preferably by the use of expansion loops and offsets. Also, provide for differential movement of piping at pier expansion joints. Piping and outlets must be identified and color-coded in accordance with Chapter 6.

### **3-3.5 CV, CVN, LHA, and LHD Requirements (All Classes).**

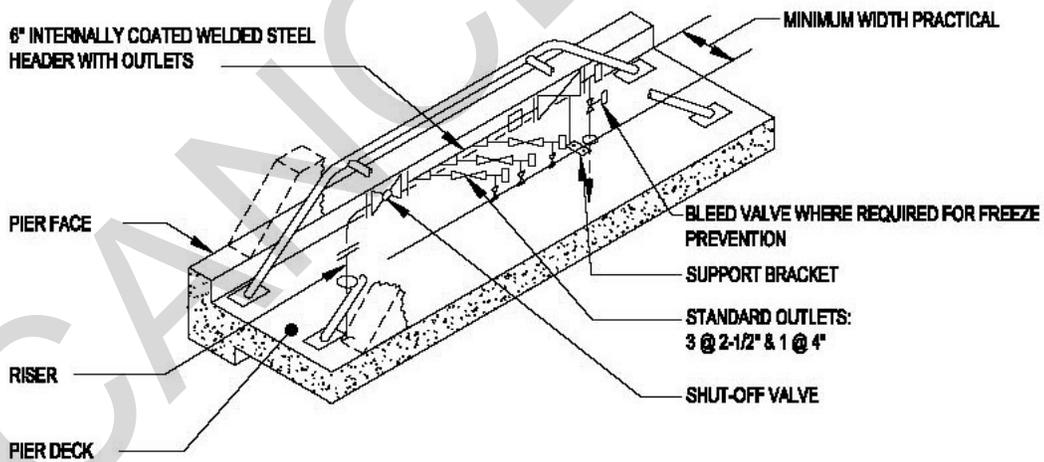
At existing installations where insufficient saltwater pressure exists, the pressure should be increased to provide 150 psi (1034 kPa) residual pressure at the pier outlets. Pump-discharge pressure must be sufficient to provide the required residual at the rated design flow. The following special requirements apply to these large class ships:

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Figure 3-4 Typical Salt or Non-Potable Water Outlet Assembly



NORMAL CONFIGURATION



LOW PROFILE CONFIGURATION

### **3-3.5.1 Special Outlets.**

In lieu of the typical outlet assembly, provide four 4 in (101.6 mm) gate-valved hose connections in a 8 in (203 mm) manifold arrangement with a 8 in (203 mm) riser at each of two locations. Approximate locations of outlets for aircraft carriers should be as indicated on Figure 3-6. For LHA and LHD ships, determine locations from NAVSEA or from the Activity. Except for the riser size, outlet design and configuration should be similar to outlets at other locations and which serve the smaller ships.

### **3-3.5.2 Upgrading.**

Permanent changes to existing pier systems for upgrading of the fire protection system (where permanent system has been justified) should be a separate high-pressure system. Provide pipes, fittings, and valves with a pressure rating of 250 psi (1724 kPa) minimum. Existing low-pressure saltwater systems may remain in place for cooling/flushing and for fighting fires on piers when handheld hose lines are required.

### **3-3.5.3 Portable or Mobile Pumps.**

Supplemental large-volume portable or mobile pumps may be utilized to augment the salt-water supply from a permanent system. Existing systems that can supply a portion of the requirement at 150 psi (1034 kPa) residual pressure may remain unchanged. However, when portable or mobile systems are used at drydocks or repair facilities, the capacity of the permanent system should be no less than 5000 gpm (18,925 lpm).

### **3-3.6 Other Nuclear-Powered Ship Requirements.**

For active and repair berthing or docking, the requirements are the same as those for conventionally powered ships of similar type.

## **3-4 POTABLE WATER SYSTEMS.**

Potable water should be provided for all berthing spaces so that ships may be supplied water. For graving drydocks, refer to UFC 4-213-10, *Design: Graving Drydocks*. Lastly, supplemental utility data as well as specialized technical data is added to the end of this chapter.

### **3-4.1 Quantity and Pressure Requirements**

#### **3-4.1.1 Active Berthing (Single or Multiple Berths).**

For single berths, provide a potable water supply of 1000 gpm (63 l/s) for all berth lengths up to 2000 ft (610 m). Design for a minimum residual pressure of 40 psi (276 kPa) downstream of an RP2 backflow preventer located at the most remote outlet on the pier. Where the pier length accommodates more than one berth, provide a potable water supply of 1000 gpm (63 l/s) for the first 2000 ft (610 m) of berth, plus 500 gpm (32 l/s) for each additional 2000 ft (610 m, up to a maximum of 2000 gpm (126 l/s), and with a minimum pressure of 40 psi (276 kPa) downstream of an RP2 backflow preventer located at the most remote outlet. Potable water requirements for selected ship classes are defined in Appendix C. For ships not included in Appendix C use data from a similar ship or obtain the expected data from NAVFAC 4V4/ or USACE.

Figure 3-5 International Shore Connection for Ship Fire Mains

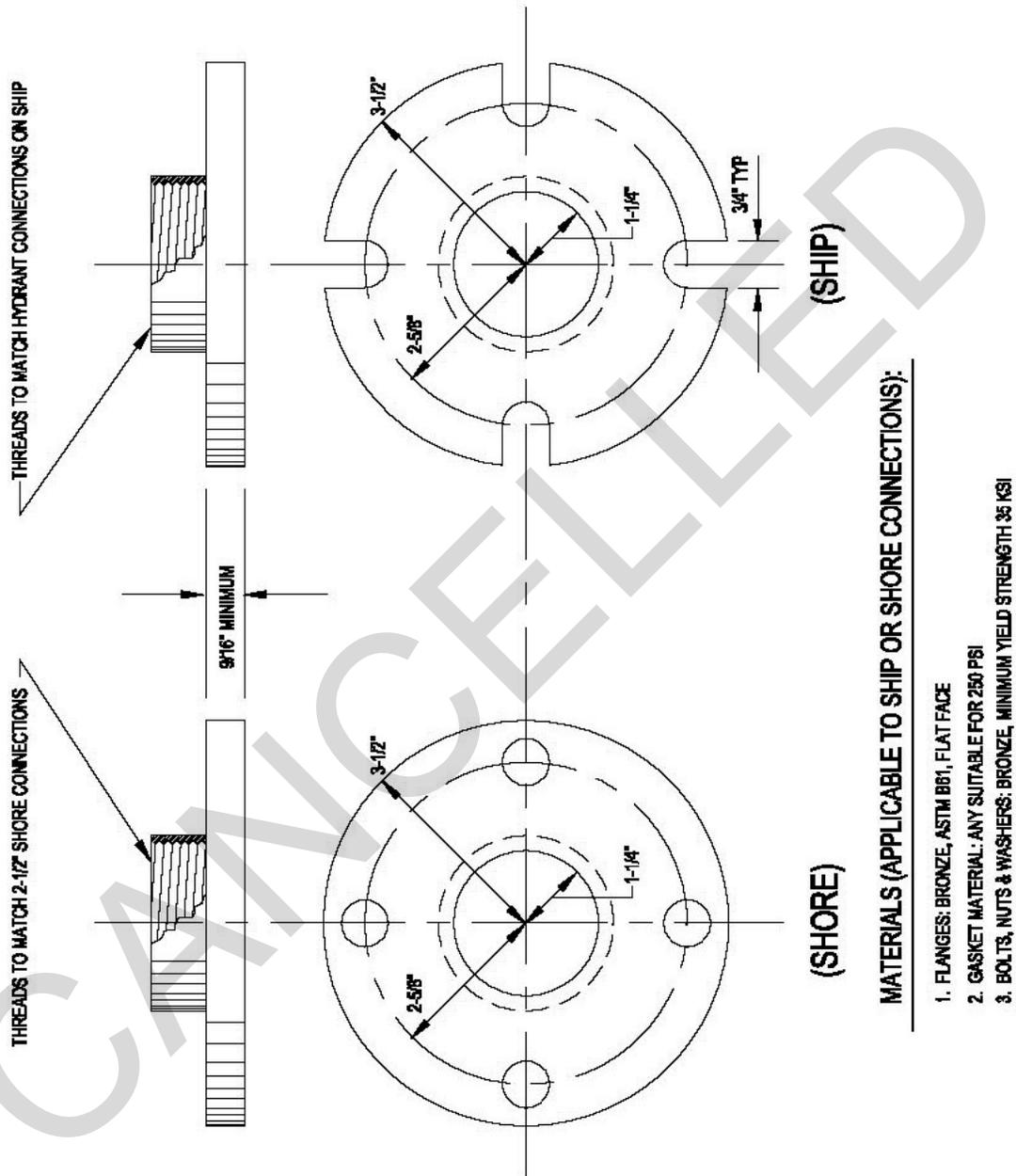
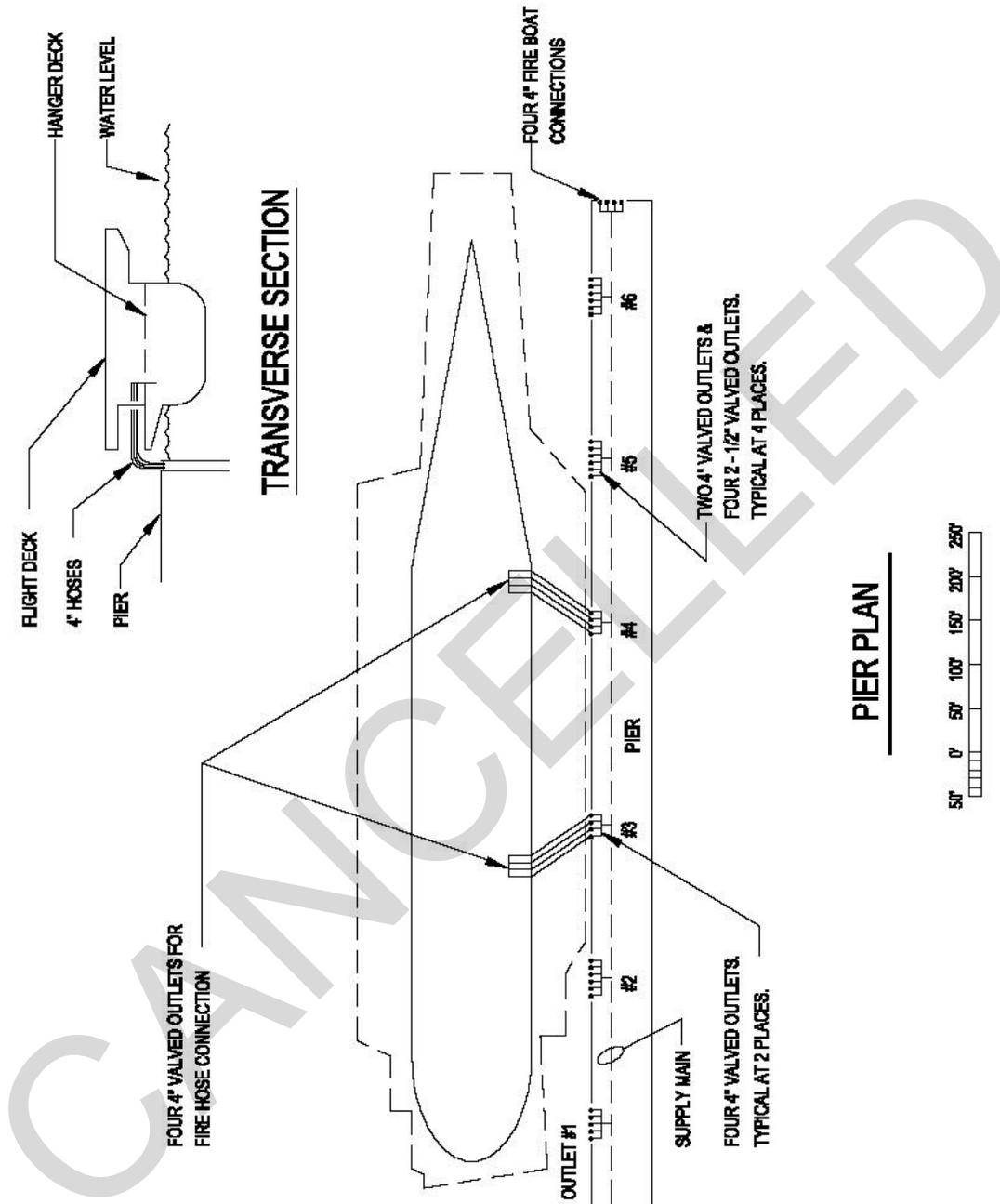


Figure 3-6 Salt or Non-Potable Water for CV, CVN Classes at Pier



**3-4.1.2 Repair Berthing.**

The potable water requirements are defined in Appendix C. Add the quantities indicated for each ship (including nested ships) and that total available on the pier. Base the peak rate of flow for sizing the main on providing the entire daily flow requirements defined in Appendix C, applied to all ships on a pier or wharf, at a constant flow rate, within an 8-hour period, and at a residual pressure of 40 psi (276 kPa) minimum at the furthest shore connections. It is noted that this data is based on 30 gpd/man (114 lpd/man).

**3-4.1.3 Multiple Piers.**

Determine total usage for multiple piers by summing daily flows for all ships at all piers or wharves assuming 30 gpd/man (114 lpd/man). Determine the peak-flow rate for multiple piers by summing peak-flow rates for all piers or wharves as determined by the method described above and then multiplied by a diversity factor of 0.75.

**3-4.2 Piping System Design Criteria.**

For piping materials and installation requirements, refer to \4\ UFC 3-230-19N /4/, *Water Supply Systems*. Ductile iron is typically used for the main lines while PVC or copper is used for branch lines. For piping under a pier or wharf, evaluate the relative advantages of cement-lined ductile iron versus cement-lined steel pipe with an extruded polyethylene or polypropylene exterior coating. Provide an ultra violet inhibitor in polyethylene or polypropylene coatings exposed to sunlight. For coated pipe, use polyethylene, heat-shrinkable sleeves and/or tape wrapping at joints and fittings. Type of joint requires particular consideration. Provide pipe hangers and associated support assemblies in accordance with paragraph 2-4.1.3. Provide means of pipe movement due to thermal expansion, preferably by use of expansion loops or offsets. Also, provide for differential movement of piping at pier expansion joints. Consider effects of transients from waterhammer.

**3-4.3 Location and Arrangement of Piping Mains.**

As a general rule, provide a single water main with cross-branch piping to outlets for active berthing piers and for repair piers 50 ft (15.2 m) or less in width. For repair piers wider than 50 ft (15.2 m), provide piping mains on both sides of the pier with a cross connection at the outboard end of the pier (loop configuration). Coordinate piping with structural conditions and arrange mains for the best combination of versatility, security, and overall cost. Normally, it is more desirable to provide a looped main rather than an equivalent single main. Provide isolation valves at appropriate locations for reliability of service during emergency repairs.

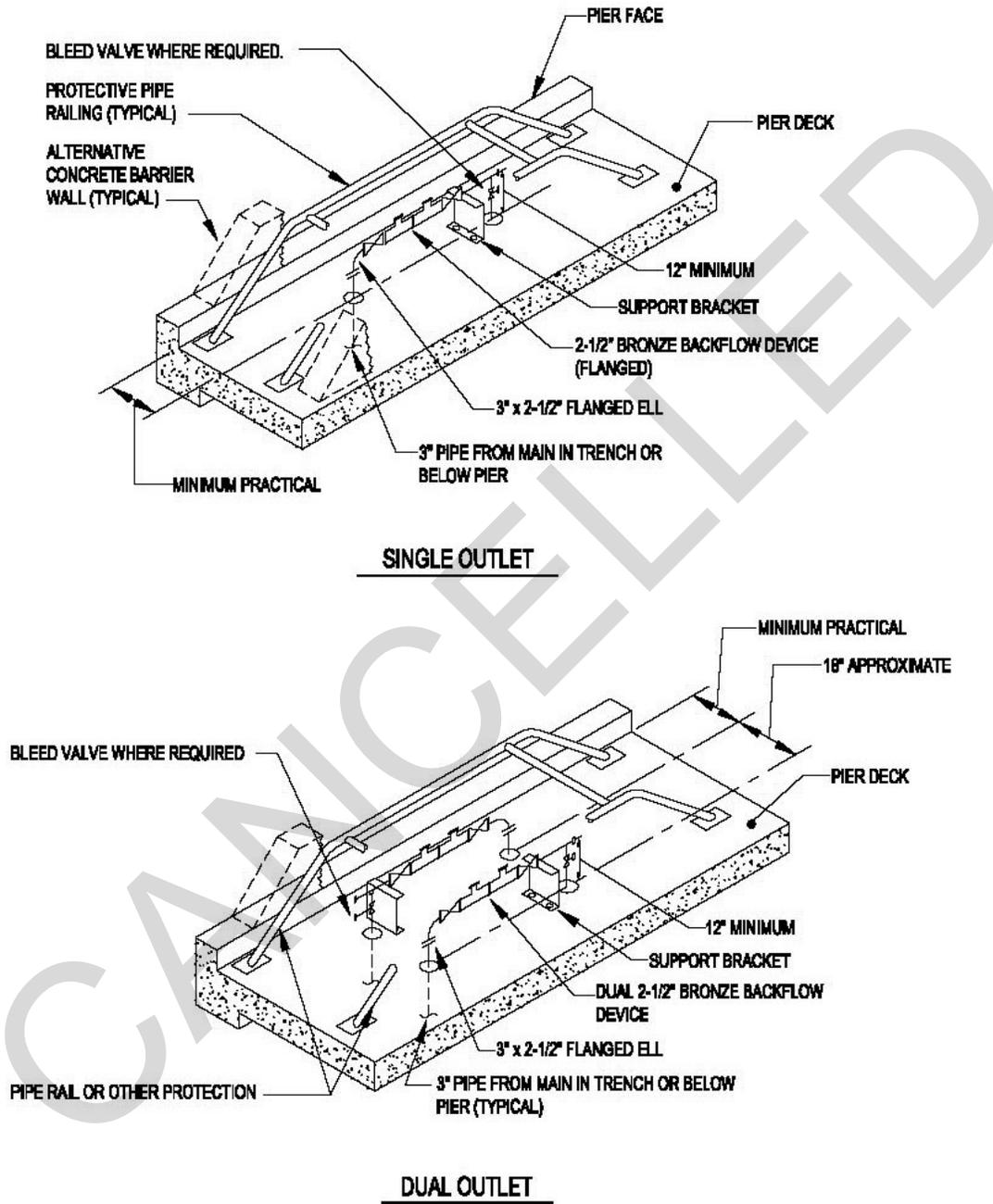
**3-4.4 Piping and Outlets.**

See Figure 3-7. Provide at least one 2-1/2 in (63.5 mm) connection at each service outlet except as specified in paragraph 3-4.6 for large ship requirements or where nesting is anticipated. Branch piping from mains to outlet risers should be not less than 2-1/2 in (63.5 mm), and not less than 4 in (101.6 mm) where dual 2-1/2 in (63.5 mm) connections are fed by a common branch. Terminate shore connections with a 2-1/2 in

(63.5 mm) gate valve with hose threads (national hose threads) and a chained cap. Provide a reduced-pressure type backflow prevention device in accordance with \4\ UFC 3-230-19N /4/. Identify and color-code potable water outlets on piers and wharves in accordance with Chapter 6. If static pressure in supply mains is greater than 80 psi (552 kPa) for any portion of the day, then provide regulators set at 80 psi (552 kPa) maximum.

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Figure 3-7 Typical Potable Water Outlet Assembly



### **3-4.5 Location and Spacing of Outlets.**

The pier locations of ships potable water connections may be determined by the data defined in Appendix C. Refer to Chapter 2 for a description of methods to be used in establishing shore-utility station spacing on piers and wharves.

### **3-4.6 Specific Ship Requirements**

#### **3-4.6.1 CV and CVN Ship Requirements (All Classes).**

Design systems as specified above except provide a 4 in (101.6 mm) branch line, a 4 in (101.6 mm) reduced pressure backflow prevention device, and an outlet assembly at outlet locations 3 and 4 of Figure 3-6. Provide a 4 in to 2-1/2 in (101.6 mm to 63.5 mm) reducer for each location to allow the use of these outlets by ships other than carriers.

#### **3-4.6.2 LHA and LHD.**

Design systems as specified for CV/CVN class ships except provide dual outlets at each utility connection group, one 4 in (101.6 mm) reduced-pressure backflow prevention device, and an outlet assembly near the center of the berth. Provide a 4 in to 2-1/2 in (101.6 mm to 63.5 mm) reducer to allow use of the 4 in (101.6 mm) outlet with other ships.

#### **3-4.6.3 Additional Requirement for Nuclear-Powered Ships.**

A "pure" water supply as defined by NAVSEA is required for all nuclear-powered ships. Due to the quantities involved and the problems of contamination and quality control, tank truck delivery will normally be used rather than the installation of piping and outlets on the pier. Location(s) of the tank truck must be coordinated with all other pier features. Coordinate with the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT.

#### **3-4.7 Quality.**

Refer to \4\ UFC 3-230-19N /4/. The quality of water must meet or exceed the requirements of 40 CFR, Part 141, U.S. Environmental Protection Agency's *National Primary Drinking Water Regulations* and the *National Secondary Drinking Water Regulations*.

#### **3-4.8 Metering.**

Provide metering of potable water supply to piers or groups of piers unless instructed otherwise. See paragraph 2-5. Use compound-disc or magnetic-flow meters to achieve a high range of registration.

### **3-5 POL SYSTEMS.**

Refer to \4\ UFC 3-460-01 Design: Petroleum Fuel Facilities /4/. Fuel and lube oil connection locations on various ships are defined in Appendix C. Pier fueling connections and hoses must be kept a minimum of 25 ft (7.6m) away from any possible ignition sources, such as pier power outlets, telephone terminal panels, and fire alarm equipment. Required POL connection sizes must be obtained from specific ship data available from NAVSEA. General requirements for pipe hangers and support

assemblies (paragraph 2-4.1.3) and for metering (paragraph 2-5) are applicable. Identify POL outlets on piers and wharves and color-code in accordance with Chapter 6. POL piping systems also require special consideration for protective coatings and cathodic protection systems. See paragraph 2-4.4. Refer to military specifications MIL-C-52404, *Connection Hose, Fire and Water* and MIL-S-12165, *Strainer Suction, Fire Hose, and Strainers, Suction, Hose* for POL connection types. Consult with the cognizant fire protection engineer, both at the local level and at the NAVFAC \4\ FEC /4/ OR USACE DISTRICT level.

### **3-6 OILY WASTE SYSTEMS.**

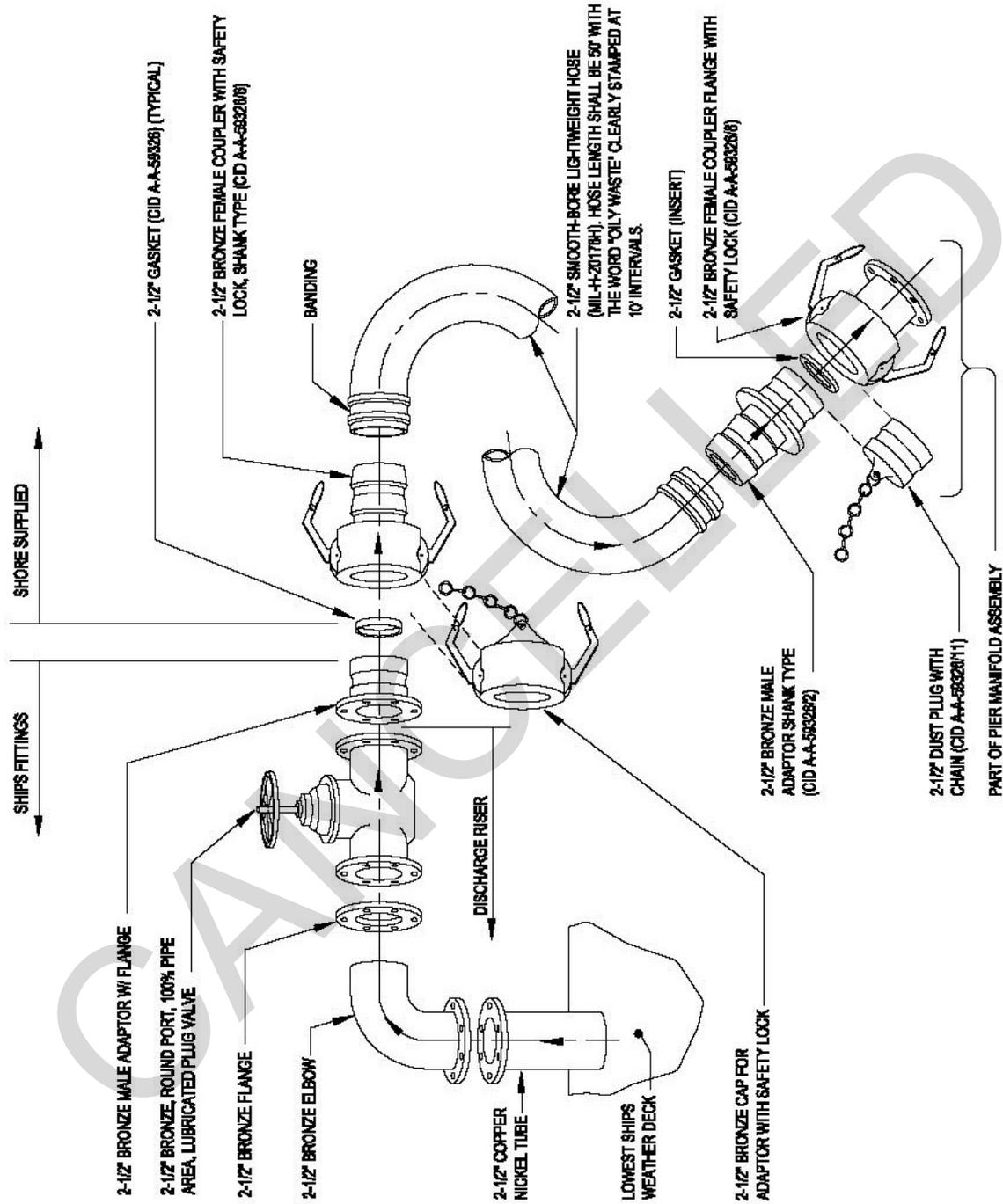
For typical ship-to-shore connection requirements, see Figure 3-8. Oily waste collection must be provided at all berths for 100 gpm (6.3 l/s). Oily waste system requirements for selected ship classes are defined in Appendix C. For ships not included in Appendix C, use data from a similar ship or obtain the expected demand from NAVFAC \4\4/ or USACE.

The system is usually a fixed piping system. However, tank truck or barges may be used for transient berths if allowed by the Activity. Ship waste oily barges (SWOB) should not be used at submarine berths due to potential hull damage. Design ships oily waste (bilge water) systems in accordance with \4\ UFC 4-832-01N /4/, *Design: Industrial and Oily Wastewater Control*. Also, refer to 40 CFR, Part 1700, *Uniform National Discharge Standards for Vessels of the Armed Forces*, and to NAVSEA S9593-BF-DDT-010, *Oil Pollution Abatement System* for ship design. Connection locations for ships oily waste are defined in Appendix C. Refer to Chapter 2 for a description of utility spacing requirements. In climates subject to freezing temperatures, oily waste lines must be properly protected. Refer to Chapter 6.

#### **3-6.1 Pierside and Barge Collection of Shipboard Oily Waste.**

Shipboard oily waste must not be directly discharged to public waters. In many cases it is unsuitable for discharge to a POTW. Requirements are: (1) provide full treatment to direct discharge standards; or (2) provide pretreatment to reduce pollutants to acceptable levels for municipal sewer discharge. Bilge wastes are normally the primary influent (both in volume and contaminant concentration) to an oily waste treatment system. Occasionally, compensating ballast water is discharged from ships and barges directly overboard. As of this writing, Puget Sound, Washington activities are required by the local regulatory agencies to collect compensating ballast water during ship's refueling operations. This waste contains lower contaminant levels than bilge wastes but usually requires treatment before disposal. Lastly, the designer should refer to the Naval Facilities Engineering Service Center's (NFESC) *Bilge and Oily Wastewater Treatment System* as an alternative system for pollution prevention. Every project must be evaluated on a project-by-project basis. The designer must consult with the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT, the Activity, and the responsible Environmental Engineers, both at the local level and at the NAVFAC \4\ FEC /4/ OR USACE DISTRICT level.

Figure 3-8 Ship-to-Shore Oily Waste Hose Connection



### **3-6.2 Ship Oily Waste Generation.**

Collection may take the form of transfer systems to trucks or barges, or a facility pipeline system. Coordinate with environmental requirements to provide an environmentally acceptable collection system with the most economical life cycle cost.

**3-6.2.1** Primary sources of ship-generated oily wastewater are bilges, oily waste holding tanks for collecting lubricating oils and water contaminated fuel, condensate lines, and tank cleaning water. Sonar dome pumping water is not normally collected as part of the oily waste collection system. The oil content in the bilge water normally varies from 100 ppm (0.01 percent) to 10,000 ppm (1.0 percent). The rest is mostly saltwater of unknown chloride content. The oil content of ship discharges overboard is limited to 20 ppm or less within 12 nautical miles of the nearest land. In ports that restrict the direct discharge of ballast water, the ballast water can be discharged from most ships (other than tankers) through a large diameter piping system to a ship waste oily barge (SWOB) or a YON vessel. Compensating ballast water can also be discharged directly to a pier collection system provided the liquid can be discharged by gravity flow (from ship to pier connection) and the back pressure can be kept to a minimum. The Navy policy on classification of oily wastewater is that the oily waste and waste oil (OWWO) become a waste only upon removal from the ship. In general, bilge water should be treated like any other waste.

### **3-6.3 Pumping Equipment.**

Provide basket or bar type screens on a pump inlet that can be easily removed and cleaned from an easily accessible and safe location.

Determine pump capacity and operating cycle. In order to reduce mechanical formation of emulsion at oily waste treatment plants, use positive displacement pumps (in lieu of centrifugal pumps) with pressure relief valves. Pumps should pass solids having a diameter 0.125 in (3 mm).

Provide controls suitable for Class I, Division 1, Group D hazardous classification. Use float or sonic type level controllers for pump control and alarm. Air bubbler type controllers must not be used. Provide a discharge pump control valve to minimize surge effects on equalization basins located at oily waste treatment plants. (This requirement is not applicable for positive displacement pumps.) Provide an alarm system for overflow or power failure. Provide manual override of automatic pump controllers. Low-level alarm conditions must lock out all pumps and must require manual resetting.

### **3-6.4 Piping Systems.**

Piping requirements are similar to requirements for sewage systems. (See paragraph 3-7 and the associated subparagraphs.) Piping material is typically galvanized steel. However, some local environmental regulations require double-wall piping systems. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Provide pipe hangers and associated support assemblies in accordance with paragraph

2-4.1.3. Identify oily waste outlets on piers and wharves and color-code in accordance with Chapter 6.

### **3-6.5 Metering.**

Unless instructed otherwise, specify the following to monitor the system: (1) accumulating flow meter; (2) elapsed time meter for pumps and ventilator; and (3) pump suction and discharge pressure gages. Provide gages with oil-filled diaphragm and cutoff valves. Consult with the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for any additional requirements. See paragraph 2-5 for additional metering requirements.

## **3-7 SEWAGE SYSTEMS**

### **3-7.1 Introduction.**

Design information on wastewater collection and transmission systems is extensively covered in Water Environment Federation (WEF) MOP FD-5, *Gravity Sanitary Sewer Design and Construction*. This section addresses two wastewater collection and transmission topics that are not addressed in WEF MOP FD-5: (1) pier and wharf facilities; and (2) drydock facilities.

### **3-7.2 Specialized Shipboard Sewage Characteristics and Parameters.**

Designing sewage collection systems for shipboard wastewater requires special and unique conditions that the designer must take into account. All of these special issues must be addressed and resolved.

#### **3-7.2.1 Characteristics of Ship Holding Tank Discharges.**

Ship holding tank discharges can be a major source of wastewater. These wastewaters have the following general characteristics.

- A ship's wastewater is primarily domestic wastewater but may also contain industrial wastewater depending on the ship operations.
- A ship's wastewater is more concentrated than typical domestic wastewater, a result of specific design features of the ship's wastewater collection systems.
- A ship's wastewater may contain high concentrations of dissolved solids, chloride, sulfates, and sodium if seawater flushing or ballast systems are used.

#### **3-7.2.2 Ship Discharge Values.**

Appendix C defines the maximum sewage discharge values of a ship's complement, daily flow, maximum discharge, number of pumping stations, total number of pumps, and number and location of discharge connections. Where destroyers or submarines are nested next to a tender berthed at a pier, the nested ships will discharge into the

tender. The tender will then discharge to the pier's sewage collection system at the rate listed for the tender. For nested ships, it is suggested to provide a pressure manifold to reduce peak demand flow.

### **3-7.2.3 Flow Rate Variations.**

Domestic wastewater flows at piers, wharves and drydocks can be expected to exhibit seasonal and other weather-influenced flow variations. In addition, the effect of industrial and ship discharge flows as well as the variable nature of military operations may significantly affect flow variations. To minimize flow variations, flow equalization should be considered. Equalization can be applied to specific flows (such as industrial flows or other specialized flow types) that exhibit wide variations to the entire wastewater flow. When calculating flows, consider the following.

- Industrial flows such as vehicle and aircraft wash facilities. If these flows coincide with peak domestic flows, then they should be added to the peak flows.
- Ship holding tank discharge flows. Flow rates will depend on the total volume of flow and the time required to convey the wastewater to the treatment facility. Design equalization systems to equalize the flows in order to minimize their effects on peak flows. Consider conveying the ship wastewaters to the treatment facility at night when domestic flows are low.
- Intermittent flows due to military functions. Periods of increased sewage flows will occur because of training activities or other personnel mobilization exercises common to military installations. Training activities or other mobilization exercises will create short-term increases in domestic wastewater and possibly industrial flows. These intermittent activities may create the peak wastewater flow rate. Design the sewage collection system to handle routine variations in flow resulting from training and other routine military exercises. The design must ensure acceptable performance with reasonable operational costs. (For example, an equalization system may provide flow and load dampening to accommodate these significant variations.) However, do not design facilities to accommodate peak surges resulting from emergency military mobilizations.
- Intermittent periods of reduced use. Low flows can also be a problem. Therefore, design the wastewater facility to operate efficiently over a range of flows. (For example, provide parallel trains that can be taken out of service.)
- Changes in requirements or military mission. Designs should include provisions for the system's expansion and contraction as well as system

modifications due to more stringent effluent requirements or military mission changes. In general, maximize operational flexibility.

#### **3-7.2.4 Wastewater Loadings.**

Wastewater loadings are typically calculated based on the projected flows and wastewater pollutant concentrations and are expressed in pounds per day (lb/d) (kilograms per day (kg/d)). Where possible, determine loadings by analyzing the wastewater to be treated. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT to obtain collected data and specific instructions.

#### **3-7.2.5 Ship Sewage.**

Ship sewage settles well and is amenable to biological treatment, but it may be septic. Table 3-4, "Typical Ship Sewage Concentrations", define typical concentration values. Wastes from shipboard industrial activities are not included. High dissolved solids, chloride, sulfates, and sodium concentrations apply when seawater flushing or ballast systems are used. For more information on ship sewage, refer to NAVSEA S9086-AB-ROM-010, *Naval Ship's Technical Manual (NSTM)*, Chapter 593, *Pollution Control*.

#### **3-7.2.6 Effect of Wastewaters with High Seawater Content.**

- Performance. High concentrations of seawater tend to inhibit biological treatment. Process inhibition is related to the chloride concentration of the wastewater.
  - 1) For new designs: Currently, there is an absence of pilot plant data or treatment data from similar wastewaters. Consequently, compensate for high seawater content according to the data presented in Table 3-4.
  - 2) In analyzing the capacity of existing treatment facilities to receive ship's wastewater, use figures defined in Table 3-5. If these indicate overloading solely because of chloride inhibition, conduct pilot plant tests before planning any expansion. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for instructions.
  - 3) Sudden changes in chloride concentration may upset biological processes. Consider equalization storage to limit chloride variation at the wastewater facility. For chloride concentrations in excess of 5000 mg/L, provide design limitations of 200 mg/L/h.
- Maintenance. High seawater content in wastewater will aggravate incrustation problems. Avoid fine bubble air diffusion systems and design orifices to facilitate periodic cleaning of mineral deposits. This is especially applicable to orifices in trickling filter flow distributors or in

aeration devices. Use care in selecting construction and equipment materials.

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**Table 3-4 Typical Ship Sewage Concentrations**

CHARACTERISTIC	CONCENTRATION (mg/L)
Total suspended solids	600
Total dissolved solids	20,000
Chlorides	11,000
Sulfates	1,500
Sodium	6,200
Other dissolved solids	1,300
Biochemical oxygen demand (BOD)	400

**Table 3-5 Chloride Inhibition of Biological Nitrification**

PROCESS	MAXIMUM CHLORIDE CONCENTRATION FOR NO INHIBITION	CONCENTRATION FOR CHLORIDES IN EXCESS OF MAXIMUM LEVEL (*)
Trickling filters and rotating biological contactors	5,000 mg/L	Referring to appropriate design loading curve, decrease loading an amount corresponding to one percentage point of removal efficiency per 1,000 mg/L of chlorides in excess of 5,000 mg/L
Activated sludge	5,000 mg/L	Decrease loading by 2% per 1,000 mg/L chlorides in excess of 5,000 mg/L
Aerobic and facultative lagoons	8,000 mg/L	Increase detention time by 2% per 1,000 mg/L chlorides in excess of 8,000 mg/L

**NOTES TO TABLE 3-5**

\* Highest average chloride concentration expected over 24 hours.

### **3-7.3 Pier and Wharf Systems.**

Design the ship sewage collection system for the peak flow from the maximum planned berthing with sewer flowing full. Base the design on maximum discharge of ship pumps. Provide a gravity flow system unless approved otherwise.

#### **3-7.3.1 Layout/Location.**

See Figure 3-9. Provide a single 4 in (101.6 mm) pressure rated manifold assembly at each berth. Each manifold assembly should have four single 4 in (101.6 mm) diameter pressure sewer connectors. This layout has the following advantages:

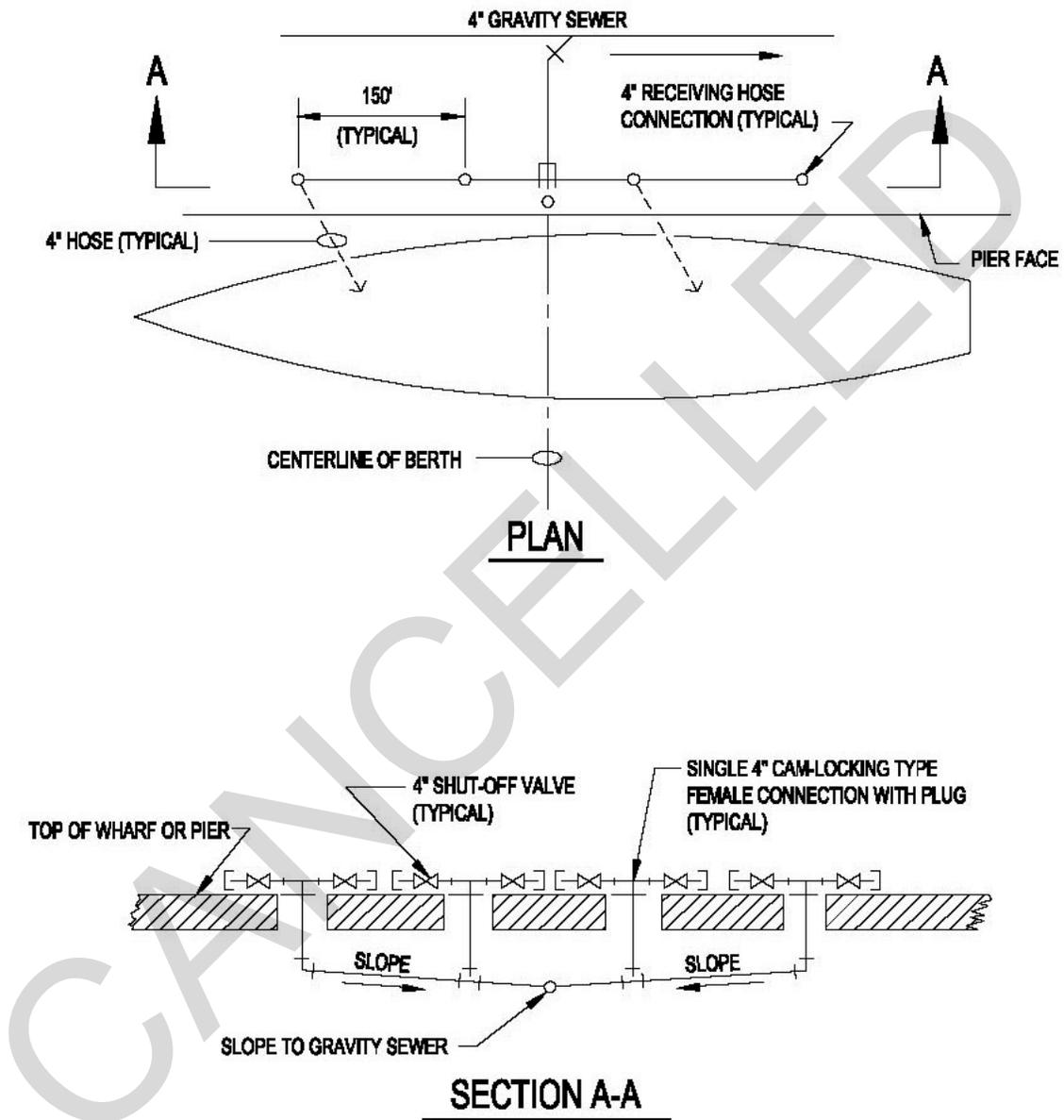
- It provides large reduction in peak flows by combining multiple discharges from a ship (or nested ships) into a single stream, thereby increasing the head on the ship's pumps.
- By reducing peak flow, it allows berthing of other ship types included in the berthing plan.
- It is self-regulating and self-cleaning plus avoids failure or maintenance problems inherent in regulating valves or other similar devices.

#### **3-7.3.2 Additional Requirements.**

See Figure 3-10 for typical collection sewer layouts on different pier types. Properly isolate each berthing space in order to prevent pumping from one berth into another and to allow ships with lower head pumps to discharge into the pier sewer.

Isolate the berths by providing one separate manifold assembly at each berth and then connect the manifold assembly directly to the pier's gravity sewer system. Where the berthing space is less than 600 ft (183 m), the number of manifold assemblies should be reduced to fit the space available. In such cases, it may be necessary to reduce the 150 ft (46 m) spacing between the assemblies. For carrier berths, two standard manifold assemblies each with four 4 in (101.6 mm) outlet connectors should be provided.

Figure 3-9 Pressure Manifold Schematic for Pier and Wharf Systems



**NOTE:** DESIGN RECEIVING HOSE CONNECTIONS FOR 3000LB PULL IN ANY DIRECTION.

Figure 3-10A Sewer Layout for Alternative Pier Types (1 of 2)

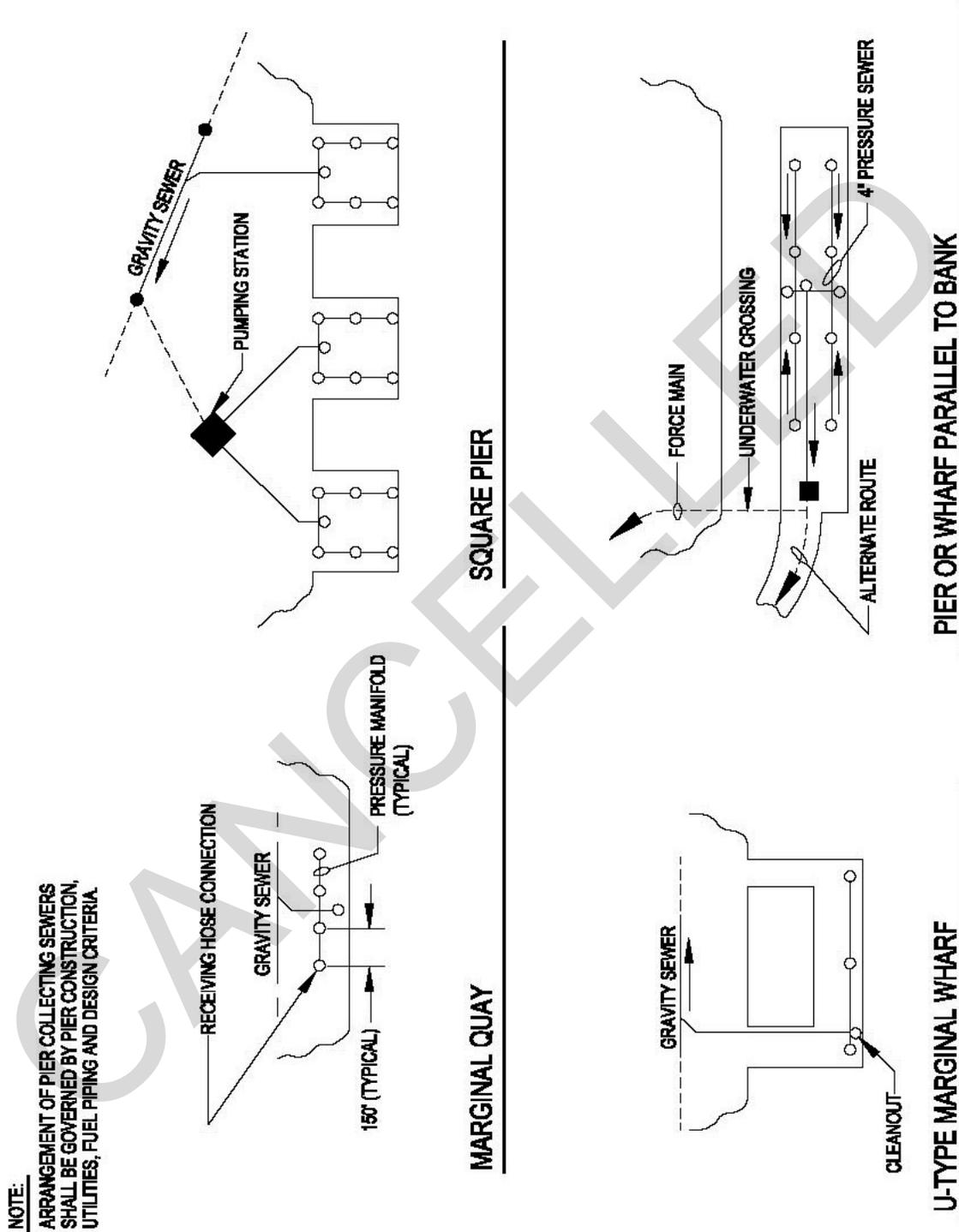
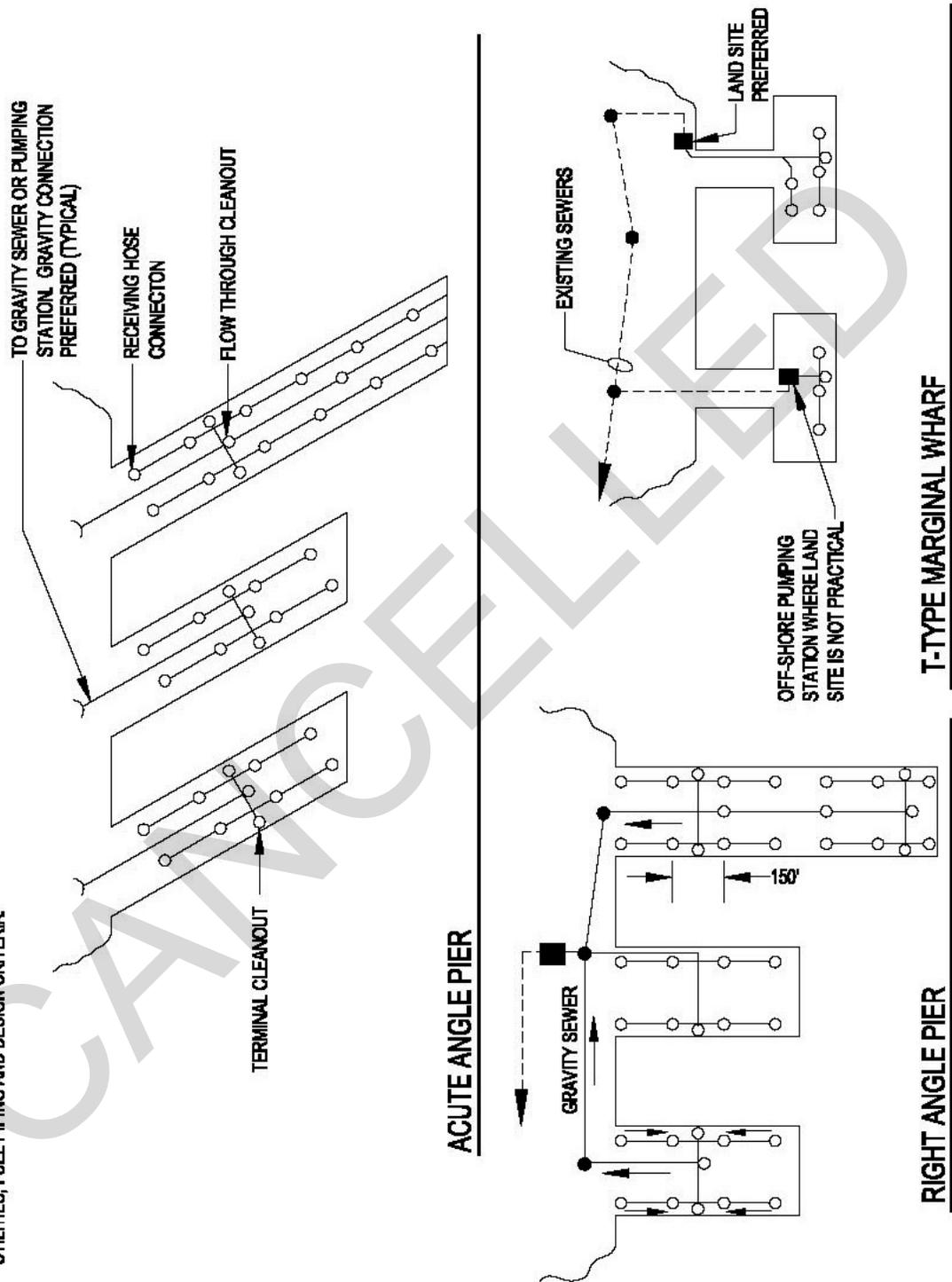


Figure 3-10B Sewer Layout for Alternative Pier Types (2 of 2)

**NOTE:**

ARRANGEMENT OF PIER COLLECTING SEWERS SHALL BE GOVERNED BY PIER CONSTRUCTION, UTILITIES, FUEL PIPING AND DESIGN CRITERIA.



**3-7.3.3 Location Details.**

See Figure 3-11 and Figure 3-12 for typical installation on piers and quay walls. Locate all collecting sewers behind the permanent wharf or pier construction and away from the fender systems. Locate pump stations off the pier and behind the bulkhead lines. If location along the pier deck is required, then do not restrict working area on the pier. Lines behind wharves should always be buried. For design of new piers and quay walls, consider locating sewers in utility tunnels. This arrangement will reduced external corrosion and improved maintainability of the sewer lines, and thus may offset higher construction costs.

**3-7.3.4 Environmental Considerations (Corrosion and Freeze Protection).**

- Evaluate paint and finish requirements. See paragraph 2.6. For ship-to-shore sewer connections (including ductile iron sewer pipe and all exposed metal such as steel support members, gratings, angles, pipe support hangers, fastening devices, and other appurtenances) it is generally recommended to provide a two-coat, coal-tar epoxy coating, conforming to Steel Structures Painting Council (SSPC) Paint No. 16. Specify a total dry film thickness of 16 mils (0.4 mm) minimum.
- Evaluate freeze protection requirements. See Figure 3-13. Pipes installed under piers or wharves in any geographic location must be protected from wave action and floating objects. Provide protective jacketing of the insulation using aluminum, stainless steel, or coal-tar epoxy coated steel where freeze protection is required. Provide structural protection for the entire length of pipe run in addition to jacketing. Use steel cage of fabricated shapes or consider the use of a catwalk system that would provide both access and piping protection. Specialized freeze protection features are defined in Chapter 6.

Figure 3-11A Typical Sewage Collection Facilities (1 of 2)

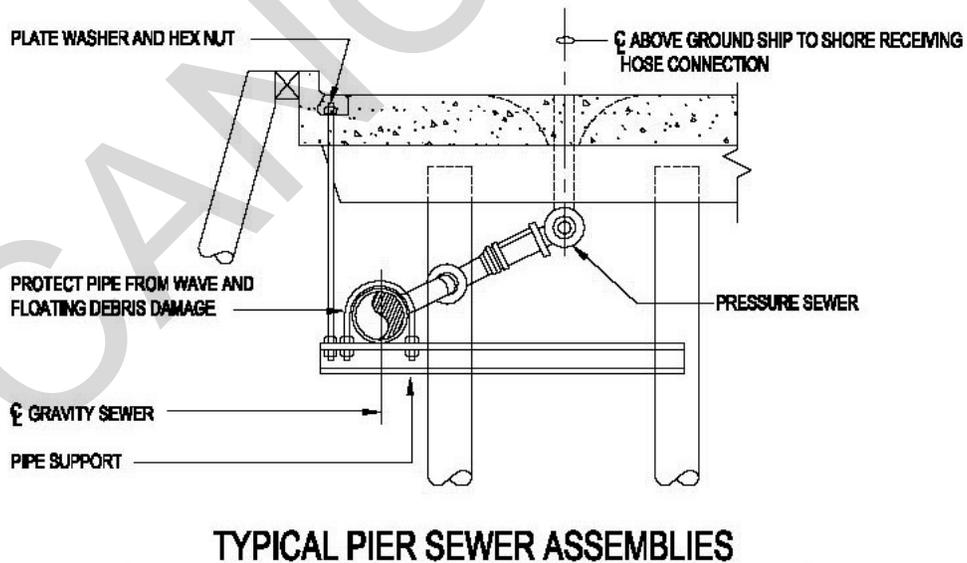
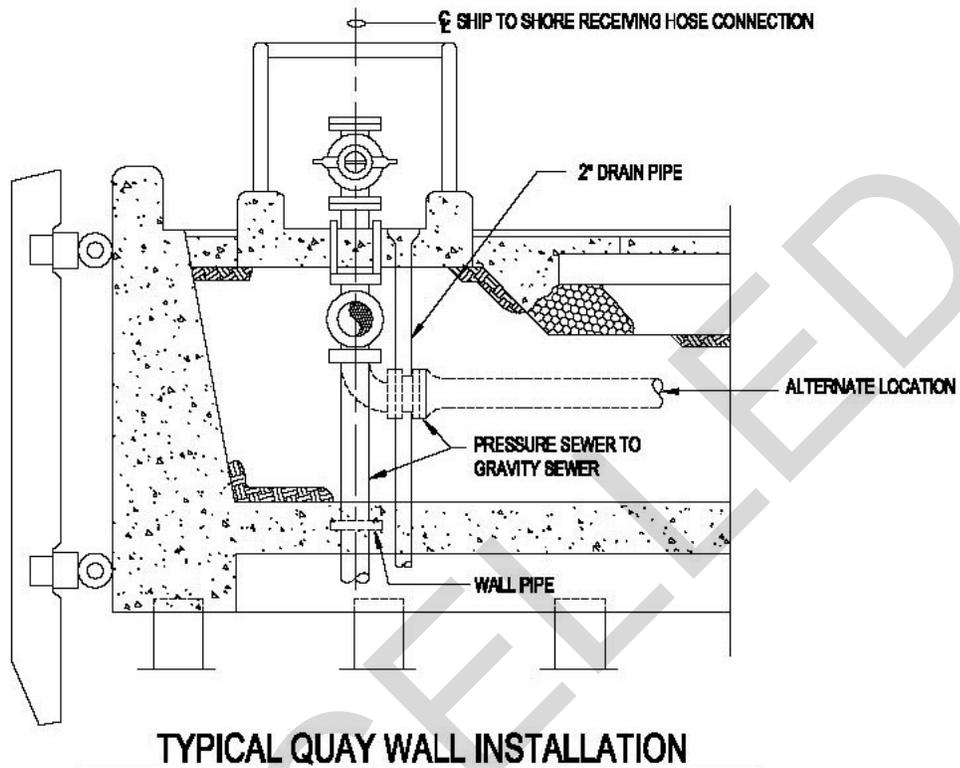
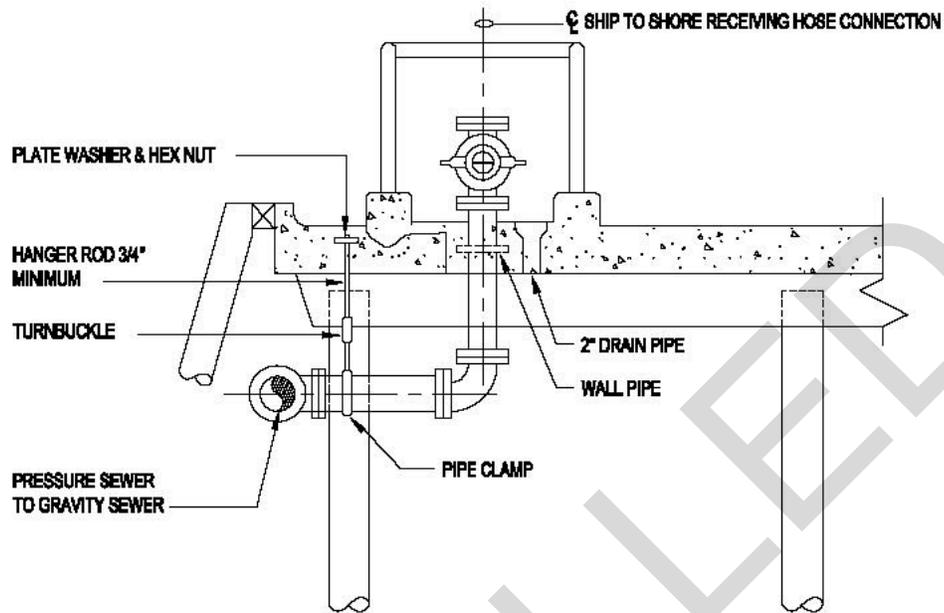
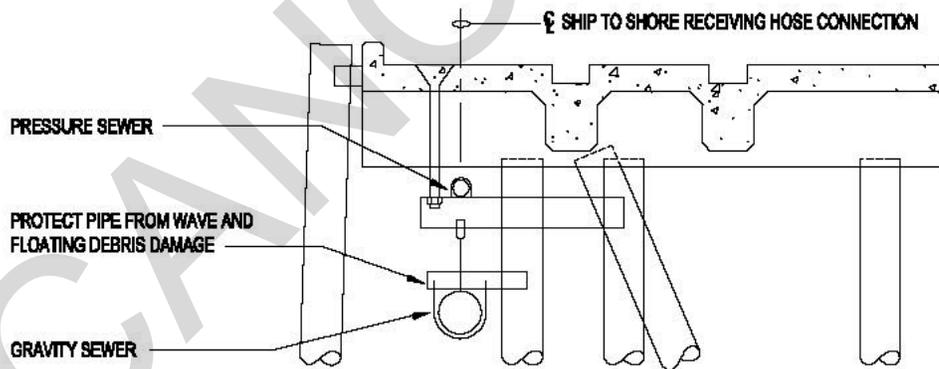


Figure 3-11B Typical Sewage Collection Facilities (2 of 2)

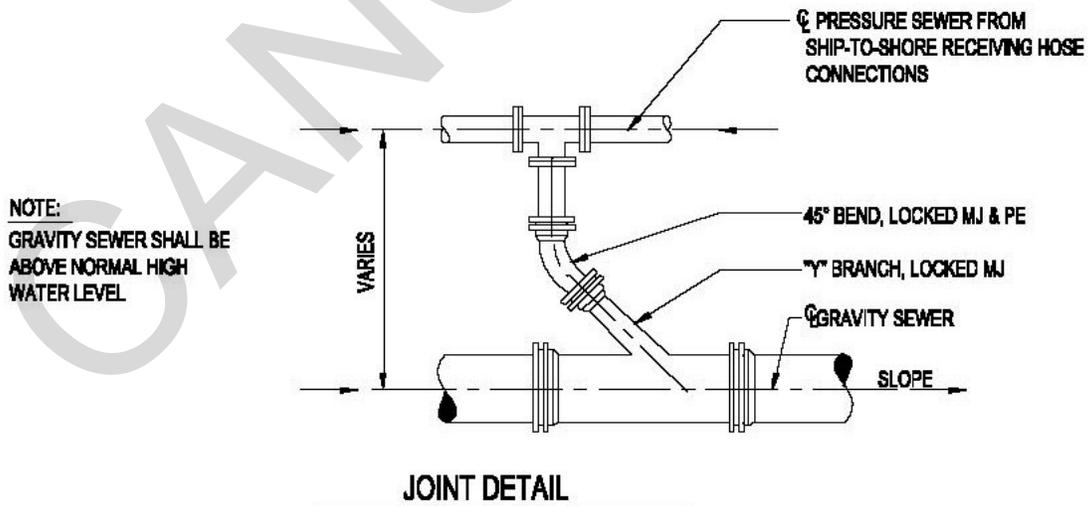
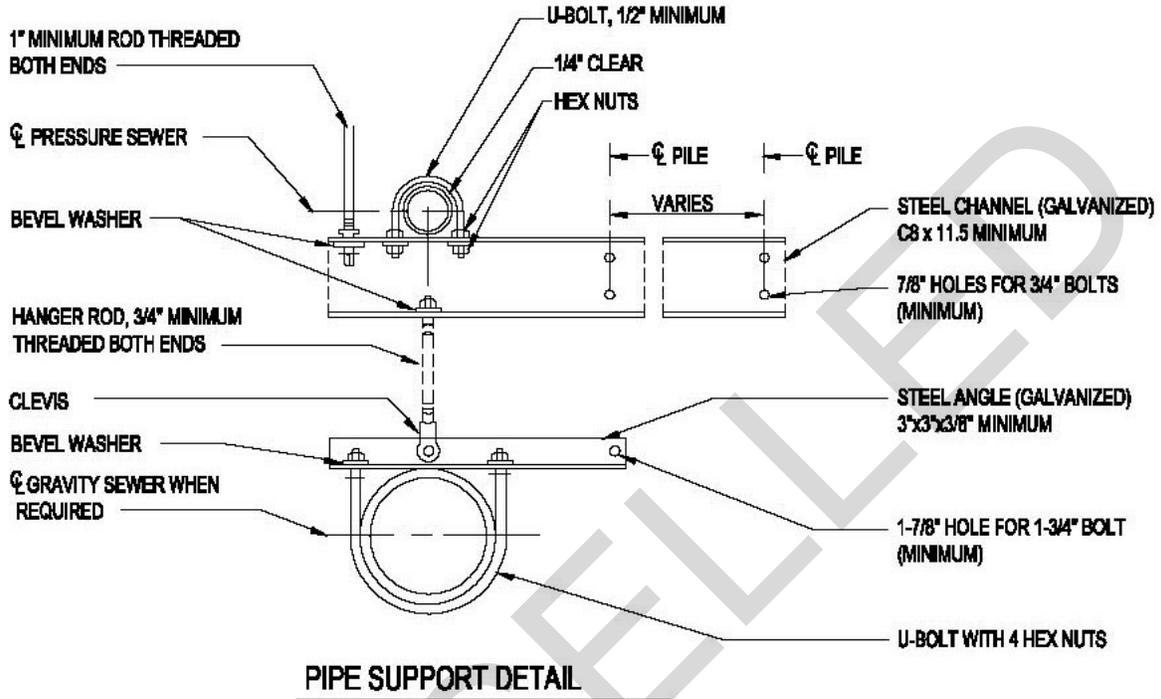


ALTERNATE PIER SEWER ASSEMBLY



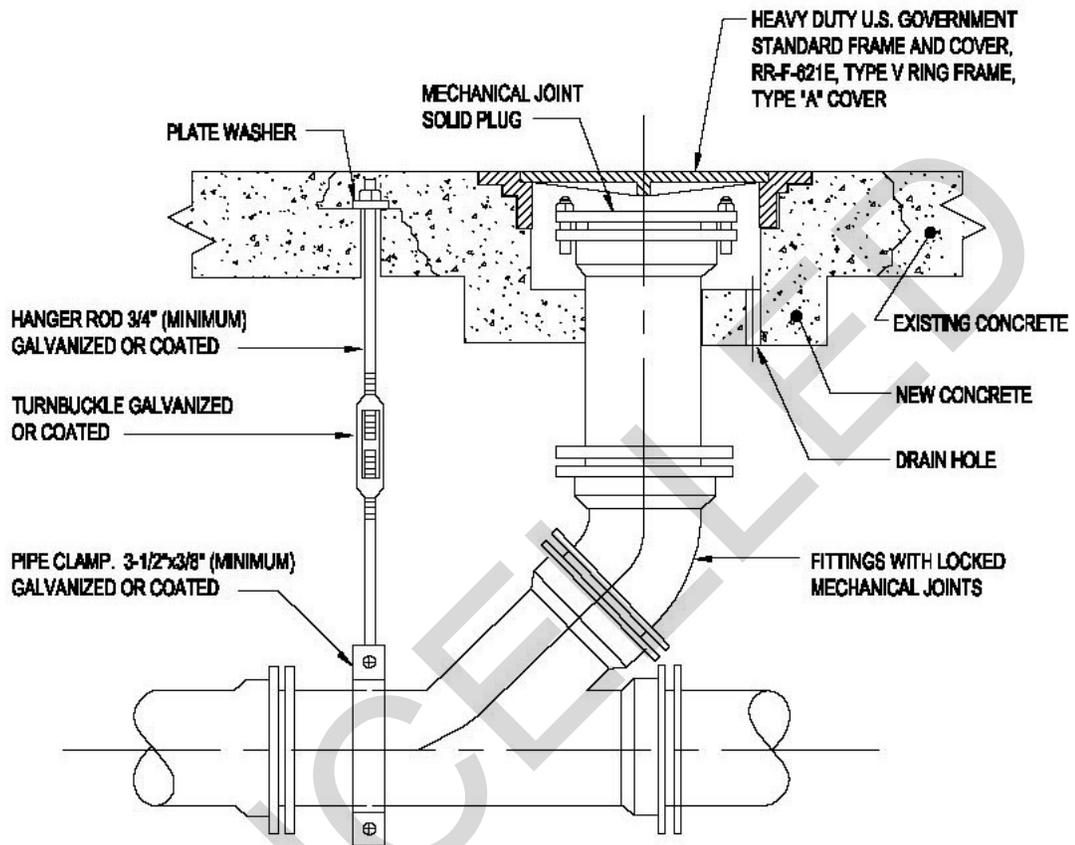
TYPE (2) PIER

Figure 3-12A Details for Sewage Collection Facilities (1 of 2)



NOTE:  
 GRAVITY SEWER SHALL BE  
 ABOVE NORMAL HIGH  
 WATER LEVEL

Figure 3-12B Details of Sewage Collection Facilities (2 of 2)



**FLOW THROUGH CLEANOUT DETAIL**

**CONCRETE DECK INSTALLATION**

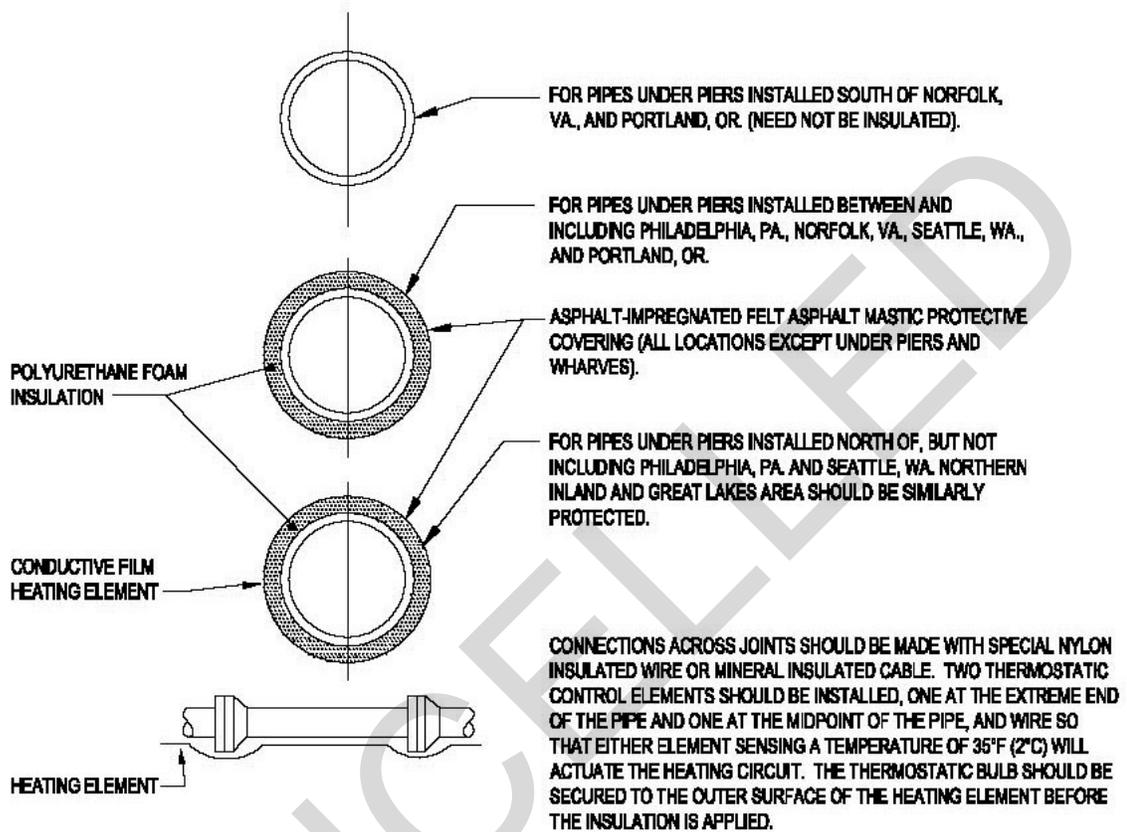
**CLEANOUT SPACING**

400' MAXIMUM FOR PIPES 15" & SMALLER  
 500' MAXIMUM FOR PIPES 18" & LARGER

**NOTE:**

FOR TERMINAL CLEANOUT USE 90° ELBOW IN PLACE OF LATERAL

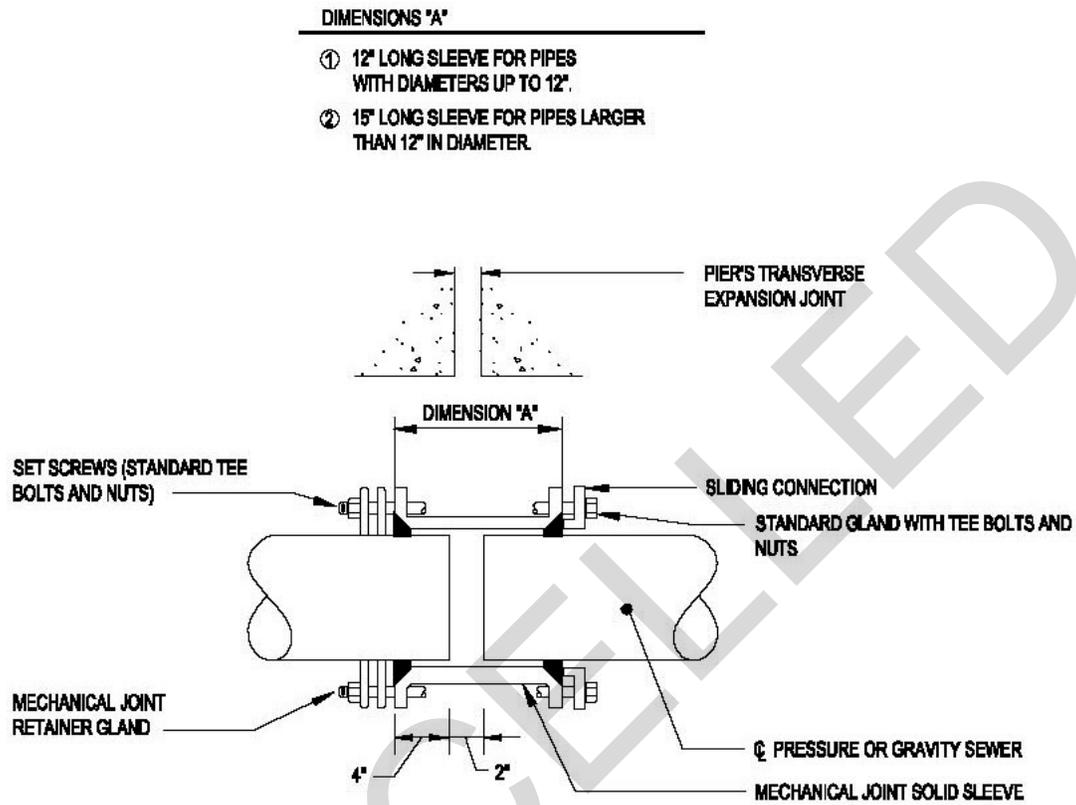
Figure 3-13A Piping Details for Sewage Collection Facilities (1 of 2)



**FREEZE PROTECTION REQUIRMENTS**

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Figure 3-13B Piping Details for Sewage Collection Facilities (2 of 2)



**EXPANSION JOINT DETAIL**

### **3-7.3.5 Odor/Septicity Control.**

Slope sewer pipes as much as possible to minimize detention time. Provide aeration in accordance with sound engineering practices. Holding tanks must be aerated unless detention time is less than 3 hours at average 24-hour flow. Keep force mains as short as possible and avoid sulfide generation. Control sulfide generation by using an injection of oxidizing chemicals such as chlorine, permanganate, or hydrogen peroxide. Consult suppliers of chemicals feed equipment regarding costs and expected performance. Refer to WEF MOP FD-5, *Gravity Sanitary Sewer Design and Construction*, for rational methods to predict sulfide generation rates and methods of control. Maintain minimum flow velocity of 3 ft/s (0.9 m/s). Provide cleanouts and air relief valves at strategic and accessible locations. Provide check valves at pump stations.

### **3-7.3.6 Structures and Appurtenances.**

Some sewer structures and appurtenances have already been defined in Figure 3-11, Figure 3-12, and Figure 3-13. Additional features are defined in Figure 3-14, and Figure 3-15. Also, see Table 3-6.

### **3-7.3.7 Pump Stations.**

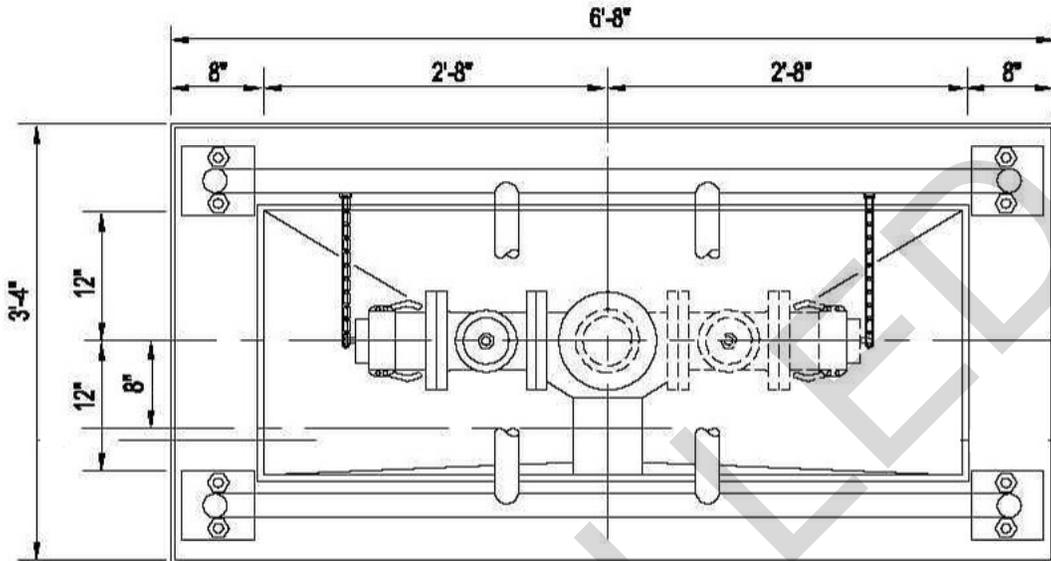
The design of sewage pump stations at waterfront facilities requires the careful consideration of all associated parameters including the premium value of real estate. The system must account for all ship flows and the connection to the station's central sewage distribution system. Careful coordination is required with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. It is imperative to provide a properly operational system at minimum construction cost and operational cost while optimizing the use of waterfront property.

### **3-7.3.8 Pipe.**

A variety of pipe materials may be acceptable to specify and will vary on a pier-by-pier basis. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for the final material selection. In general, PVC pipe may be used for gravity systems. Ductile iron pipe is preferred for pressurized systems. However, PVC pipe and HDPE pipe has been specified for pressurized systems at some pier facilities. Lined ductile iron with mechanical joints should be used for exposed locations and where high impact resistance is important. Support exposed pipe in accordance with manufacturer's recommendations. In other exposed locations where corrosion resistance is a major concern, consider specifying thermoplastic (high density polyethylene) pressure pipe with butt fusion joints. Plastic piping on pier and wharf systems should be protected from impact by floating debris and other hazards. In these cases, consider a specially designed utility trench. For buried lines, apply general sewer pipe selection guidelines.



Figure 3-15 Above Pier Hose Connection



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**Table 3-6 Special Pier Structures and Appurtenances**

STRUCTURE OR APPURTENANCE	WHERE TO USE	DETAILS	REQUIREMENTS
In-line Cleanout	Note 1	See Figure 3-12	
Regular Manhole	Note 2	Refer to UFGS 33 30 00, <i>Sanitary Sewers /4/</i>	Note 3
Drop Manhole	Note 4	Refer to UFGS 33 30 00, <i>Sanitary Sewers /4/</i>	Note 5
Siphons	Note 6	Note 7	Note 8
Intercepting Sewers	Note 9		Note 10
Traps and Interceptors	Note 11	Note 12	
Terminal Cleanout	Note 13	See Figure 3-12	Note 14
Receiving Hose Connections		See Figures 3-14 & 3-15	Note 15
Sewer Pipe Supports	Note 16	See Figures 3-11 & 3-13	

**NOTES TO TABLE 3-6**

1. Use in-line cleanout at junctions and changes of direction and when required according to spacing shown in details under regular manhole below.
2. Use regular manhole: terminally on all lines; at all junctions and changes of direction; at changes in invert elevation or slope. Otherwise, according to spacing shown below:

Pipe Size Inches (mm)	Maximum Spacing Feet (m)
18 (450) or less	400 (120)
18-48 (450-1200)	500 (150)
48 (1200) and greater	600 (180)

3. Requirements for regular manholes: lower invert through manhole a distance equal to expected loss of head in manhole, plus 0.8 times any change in sewer size. For junction manholes, check which upstream invert is critical in determining outlet invert. Raise top of manhole above possible flooding level.
4. Use drop manhole when difference between inlet and outlet inverts exceed 2 ft (0.6 m).
5. Requirements for drop manholes: for difference less than 2 ft (0.6 m), increase upstream sewer slope to eliminate drop.
6. Use siphons for carrying sewers under obstructions or waterways.
7. For siphons: maintain velocity of 0.9 m/s (3 fps). Use no less than two barrels with minimum pipe size of 150 mm 6 inches (6 inches). Provide for convenient flushing and maintenance.
8. Requirements for siphons: use WEF MOP FD-5 for hydraulic design.
9. Use intercepting sewers where discharge of existing sewers must be brought to a new concentration point.
10. Requirements for intercepting sewers: take special care against infiltration due to depth or proximity of surface water.
11. Use traps and interceptors on all outlets from subsistence buildings, garages, mechanical shops, wash pits, and other points where grease or oil can enter the system.
12. For traps and interceptors: use a displacement velocity of 0.015 m/s (0.05 fps). Grease removal: in absence of other data use 300 to 400 mg/L. Provide for

storage of 1 week's grease production (1 day if continuous removal is provided).  
Length = twice depth.

13. Use terminal cleanouts terminally on all pier collection systems.
14. Requirements for terminal cleanouts: locate where it will not interfere with other operations on the pier or other utilities.
15. Requirements for receiving hose connections: design connections to receive the discharge from ships.
16. Properly support all sewer pipes, especially pipes located under the pier. See paragraph 2-4.1.3.

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**3-7.3.9 Sewage Transfer Hoses.**

See Figure 3-14 and Figure 3-15. Provide a washing facility for washing the end couplings and the exterior of the hose. The facility should include hot potable water and a standard stock detergent. Hose washing/storage facilities must be designed so that manual lifting or pulling of hoses is minimized through the use of mechanical devices and/or arrangement of the area. Caps for each end of the hose should be provided and installed after washing. The clean hose should be stored in drying racks. For further information, refer to NAVFAC MO-340, *Ship-to-Shore Hose Handling Operations Manual*.

**3-7.4 Drydock Facilities.**

For drydock facilities, design the sewage collection system for the maximum planned docking pattern and the designed peak flow conditions. Consider the following when designing drydock collection systems.

- Separation of hydrostatic leakage from drydock wastewater: The drydock wastewater is generally not contaminated and can be discharged directly to storm sewers or open water depending on regulatory conditions.
- Separation of ship's domestic wastes from the industrial wastes generated by drydock activities: These industrial wastes include leakage, precipitation runoff, and washdown that carries sandblasting residue and paint.

**3-7.4.1 Layout.**

Ships fitted with collection-holding-transfer (CHT) should be connected to dockside sanitary sewers for CHT discharge. Ships without CHT should use scuppers and manifold connections to the ship's discharge points and then transfer to the sanitary sewer system. See Figure 3-16 for typical collection system layouts in drydock facilities.

**3-7.4.2 Pump Station Features.**

Make capacity equal to that of maximum combined ship's discharge rate of ships in drydock. Furnish portable auxiliary pumping facilities when required. Refer to UFC 4-213-10.

**3-7.4.3 Sewage Receiving Connections and Transfer Hoses.**

See Figure 3-17 for underground drydock receiving hose connections. Figure 3-15 is also applicable for aboveground drydock receiving hose connections. Aboveground receiving hose connections should be used whenever possible. See paragraph 3-7.3.9 regarding transfer hoses.

**3-7.4.4 Special Structures and Appurtenances.**

See Figure 3-16 for typical cleanout locations for drydock sewers. Locate cleanouts in main sewer at a maximum spacing of 300 ft (91 m).

Figure 3-16A Typical Sewage System Layouts for Drydock Facilities (1 of 2)

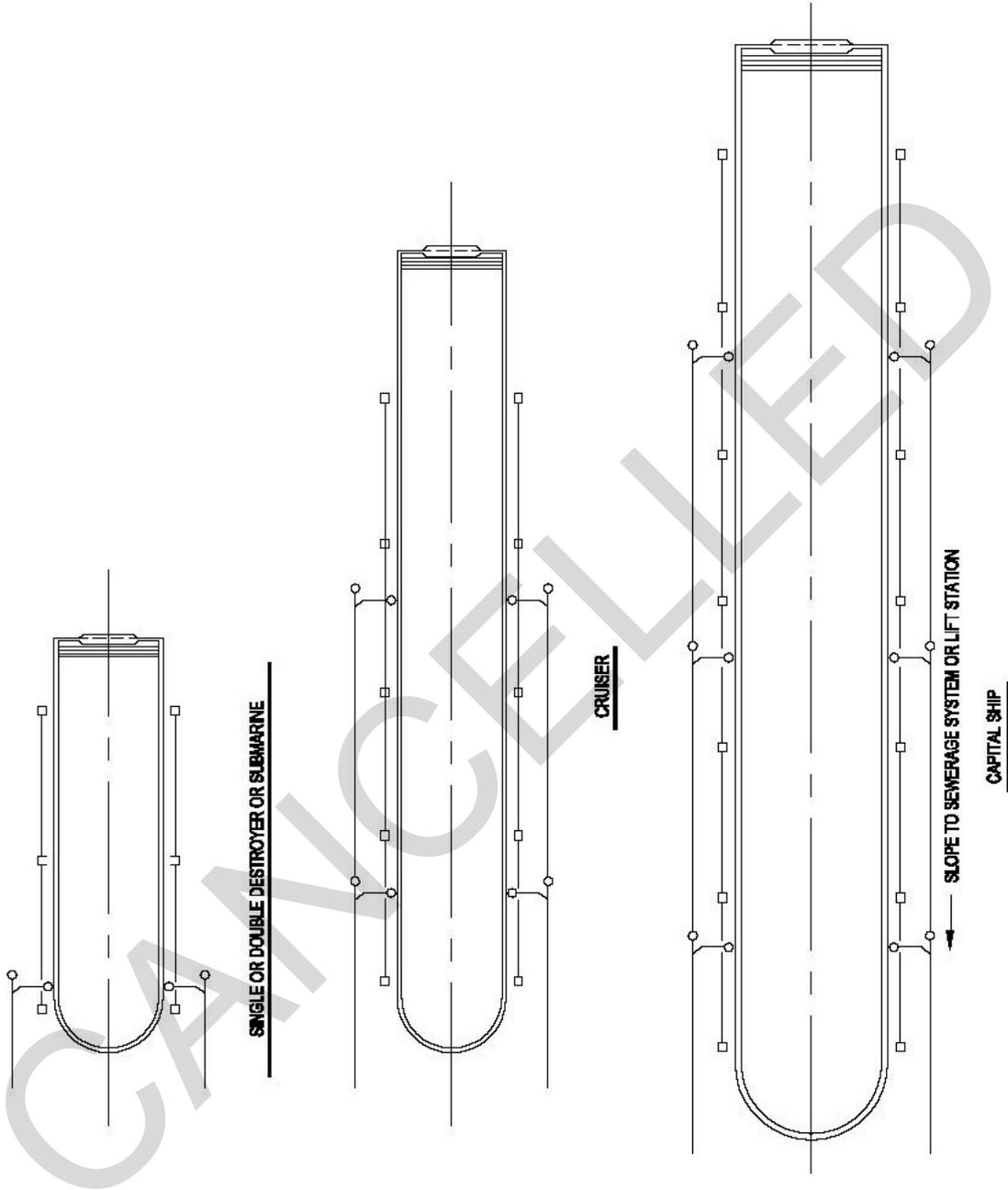


Figure 3-16B Typical Sewage System Layouts for Drydock Facilities (2 of 2)

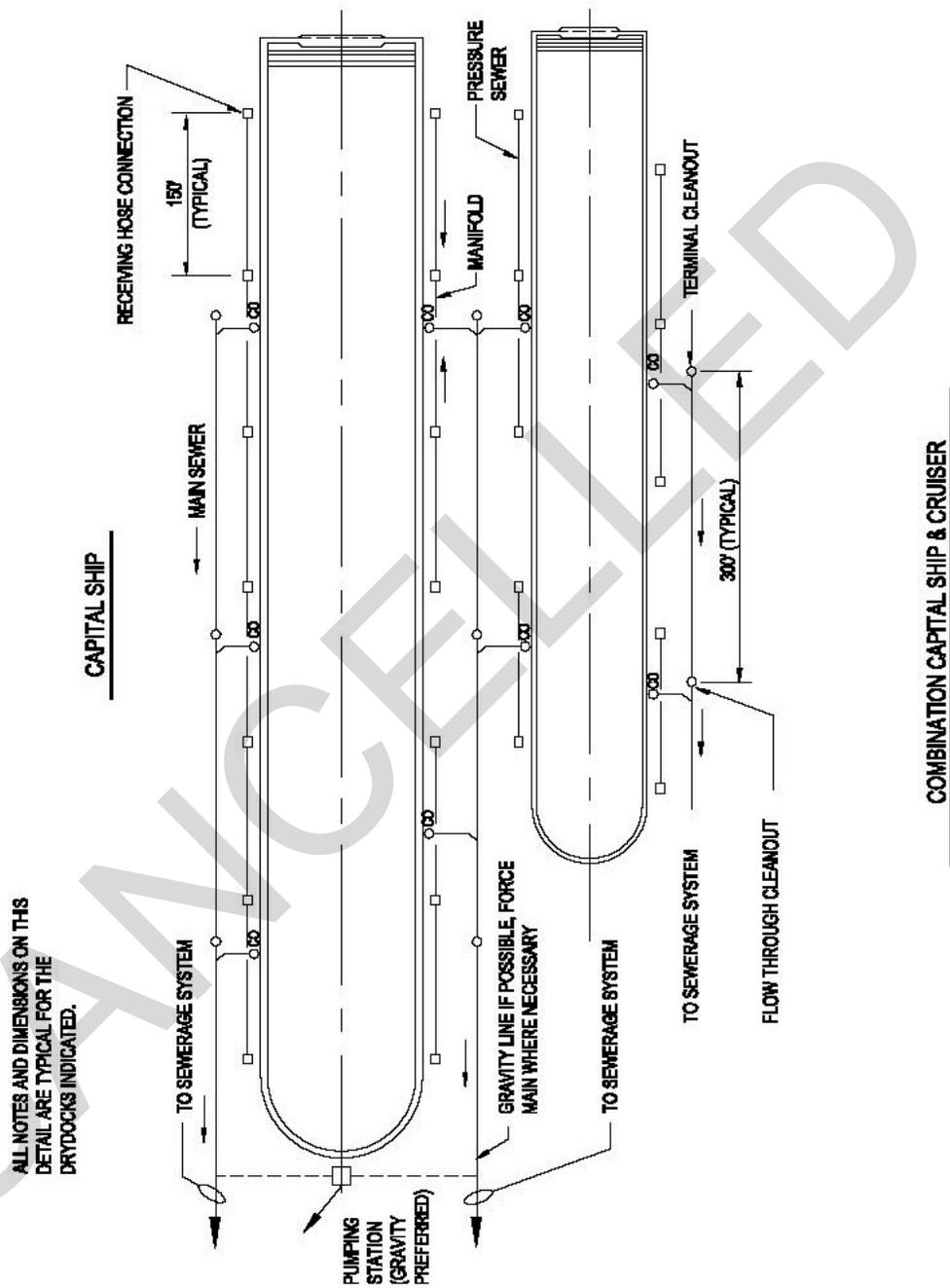
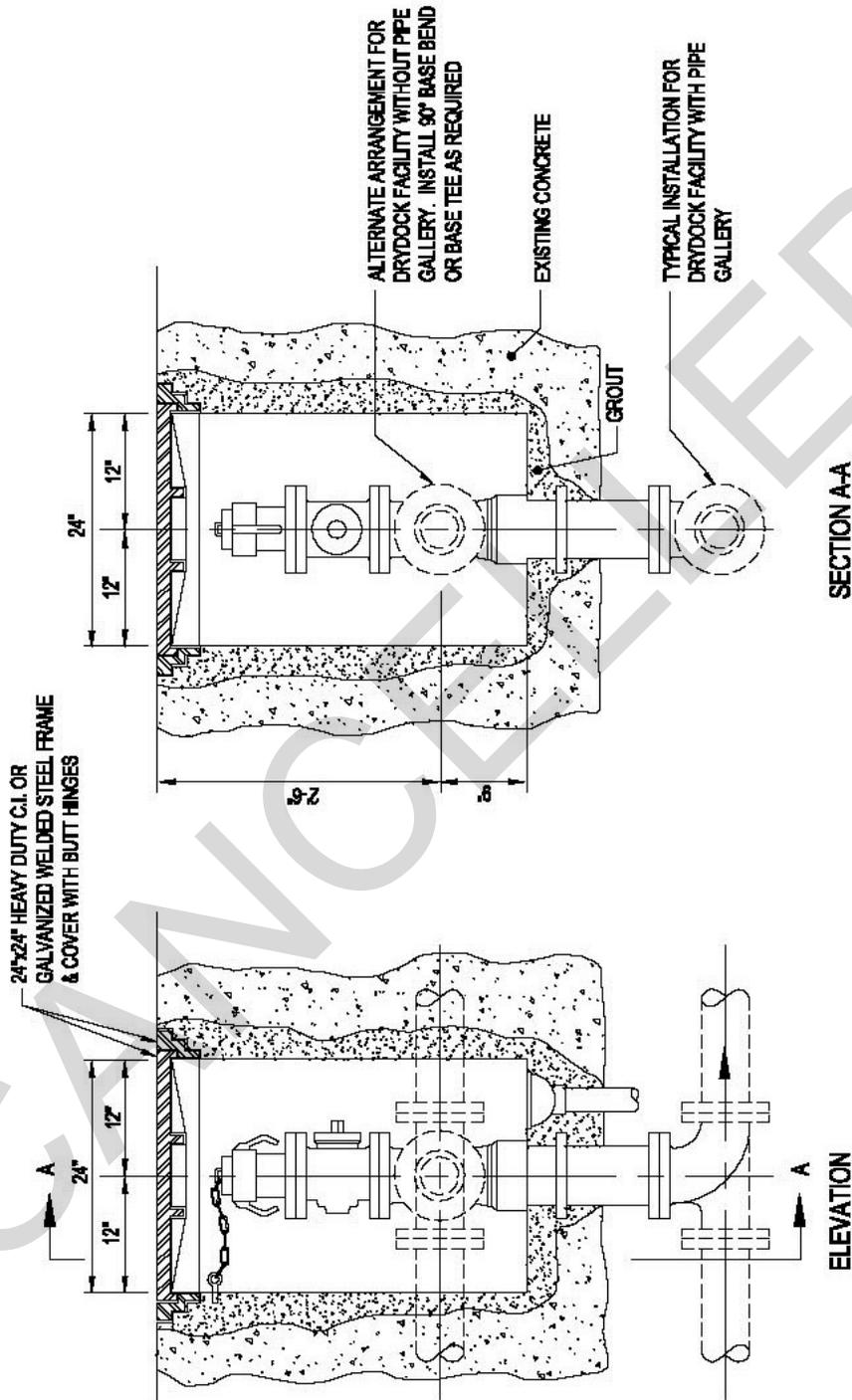
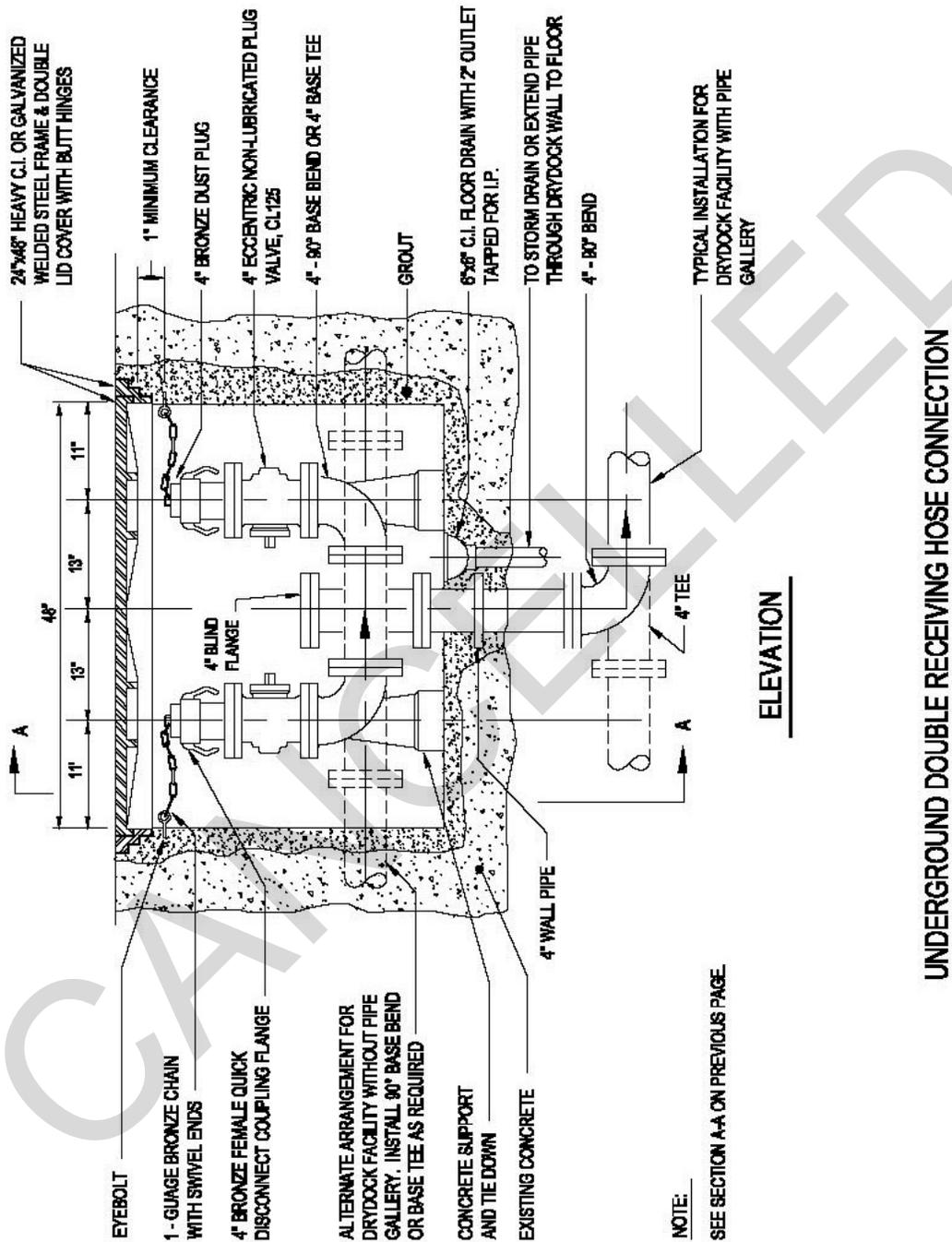


Figure 3-17A Underground Hose Connection (1 of 2)



UNDERGROUND SINGLE RECEIVING HOSE CONNECTION

Figure 3-17B Underground Hose Connection (2 of 2)



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### **3-8 ELECTRICAL SYSTEMS.**

Electrical power is required on piers, wharves, and at drydocks for ships services. This includes hotel service (shore-to-ship power), ship repair (industrial power), ships systems testing, pier weight-handling equipment, cathodic protection systems, pier lighting, and miscellaneous pier electrical systems. Materials and installation must conform to the requirements given in UFC 3-501-01, Electrical Engineering, and in NFPA 70, National Electrical Code. For drydocks, refer to additional criteria in UFC 4-213-10. Utility data and specialized technical data is available in Appendix C or it may be obtained directly from NAVFAC or USACE. In addition to the design criteria provided in this particular section, operation and maintenance guidance for electrical systems is provided in Appendix E.

#### **3-8.1 Types of Electrical Services.**

Design electrical services for piers, wharves, and drydocks for one of the two types of service listed below, as directed by the cognizant NAVFAC FEC OR USACE District.

##### **3-8.1.1 Permanent Service.**

At naval stations, shipyards, repair piers, drydocks, and other continuously occupied waterfront facilities, provide fixed electrical substations and associated facilities to accommodate the normal, maximum electrical demand load. The design may include the use of portable substations as necessary to provide the peak electrical load that may result from abnormal and unplanned electrical needs. The electrical design must include: (1) ships power requirements (hotel services) on a dedicated un-grounded power system; and (2) other facility loads on a separate grounded power system that includes loads such as lighting, weight-handling equipment, cranes, pumps, general utilization power, and the industrial power system (dedicated for ship's repair work while berthed) when required. There are three basic types of fixed substation installations: (1) the substation is installed on the lower deck of a double-deck pier; (2) the substation is installed on the pier deck of a single-deck pier or at grade level adjacent to the pier or associated waterfront facility, and (3) the substation is installed in an electrical vault located below the pier deck. The vault system has been used on many existing piers, however it is not recommended for new installations and requires approval of NAVFAC or USACE. See Appendix E and the section entitled "Substations" for additional information.

##### **3-8.1.2 Temporary Service.**

Provide temporary electrical service at waterfront facilities not continuously occupied, or at any facility where a substantial portion of the peak load will be occasional or intermittent. Provide primary feeders and high voltage outlet assemblies (5kV and 15kV) for connections to portable substations. Examples of high temporary loads include: (1) power for testing certain ships weapons systems; and (2) power for testing ships plant nuclear systems. That portion of the load serving basic pier, wharf, or

drydock functions (lighting, weight-handling equipment, and receptacles not related to ship service or repair service) must be fed from the permanent service.

### **3-8.2 Primary Power System.**

The primary distribution system on the pier or other waterfront facility normally operates in the medium-voltage range between 5 kV and 35kV and will depend upon the shore-side utility voltage(s) available. The shore-side utility system is normally already in existence. It may have to be expanded or upgraded to support a new or increased capacity pier, but will rarely require a completely new electrical utility service point. Upgrades to the system should provide the pier with a dedicated normal circuit and provisions for switching to a backup circuit. The Activity is responsible for providing justification for alternate primary feeders and standby power services required for essential operations. Special electrical primary systems may be required for certain classes of ships. These specific requirements are included in Appendix C. Provide selective coordination between system equipment components to ensure minimized downtime of ships systems due to external or internal electrical system faults. Refer to UFC 3-501-01, *Electrical Engineering*, for a description of the different types of distribution systems.

#### **3-8.2.1 Pier, Wharf, or Drydock Primary Systems.**

For permanent service, provide dual primary feeders from the shore primary system to the switching stations or substations serving the ships' hotel services and industrial loads. For temporary service, provide dual primary feeders from the shore primary system to strategic locations that serve portable substations. Conduits, ductbanks, and manholes cast integrally with the pier structure are preferred for new piers. Conduits on piers may also be installed in dedicated electrical trenches or in piping trenches that serve other utilities, or hung from above on double deck piers. To avoid damage to the conductor's insulation, electrical conduits should not be placed in close proximity to high temperature systems such as steam piping. Refer to Chapter 2 for general protection requirements.

### **3-8.3 Secondary Power Systems.**

The secondary electrical distribution system is evolving to higher voltages as the power demand on the ships continues to increase. It must be designed with the flexibility to serve the various classes and categories of ships that are anticipated to utilize the facility.

#### **3.8.3.1 Ships Power.**

Historically, the electrical system providing power for most ships has been a dedicated 480 volts (nominal), three-phase, 60 Hz, ungrounded system. This system has been supplied from substations located on piers (or at the head of the pier for shorter piers), and connected through dedicated receptacles located at the perimeter of the pier, wharf, or drydock. Currently, 4,160 volts (nominal), three-phase, three-wires, 60 Hz power is required for nuclear aircraft carriers (CVN 68 class and higher). These carriers are sometimes capable of accepting 480-volt power as well. Future classes of ships

(surface combatants and amphibious assault) will require 4,160 volts (nominal), three-phase, three-wires, 60 Hz power. Future CVN class ships will require 13,800 volts (nominal), three phase, three wires, 60 Hz power. The pier electrical distribution system must be designed to limit the fault current contribution from the shore power, at the ship's bus, to 100,000 amps (rms) for 480 v distribution, 35,000 amps for 4,160 V distribution, and 15,000 amps (rms) for 13,800 V distribution.

### **3-8.3.2 Other Ships Power Requirements.**

When required, provide direct current (dc) power and 400 Hz power for ships service. These systems must be derived from portable rectifiers or conversion equipment provided by the Activity. Provide an electrical power connection system that is supplied from the pier's permanent / industrial power system rated 277/480 Volts, three-phase, four-wires, grounded, 60 Hz. These special power systems must not be connected to the ships' dedicated hotel power service(s).

### **3-8.3.3 Permanent Pier Loads and Industrial Power.**

Other electrical requirements such as pier lighting, receptacles, weight-handling equipment and industrial power must be supplied from dedicated 480Y/277 Volt transformers. Industrial power is defined as power specifically for equipment utilized for the repair and overhaul of ships at berth and is normally only required in naval shipyards. Do not provide permanent pier load power or industrial power from the same transformers providing shore to ship hotel power.

### **3-8.4 Location and Arrangement of Equipment.**

Final locations of equipment must be made on a pier-by-pier basis in concurrence with the Activity and the cognizant NAVFAC FEC OR USACE District. Selection must be coordinated with the pier design type, other pier utilities and the pier's operational requirements. In general, provide as much clear space for cranes and vehicular traffic on the pier deck as possible. Examples of pier equipment arrangements are shown in Figure 3-18.

#### **3-8.4.1 Substations.**

The three main types of arrangements for substations are discussed in the following subparagraphs with an example of their use, where appropriate.

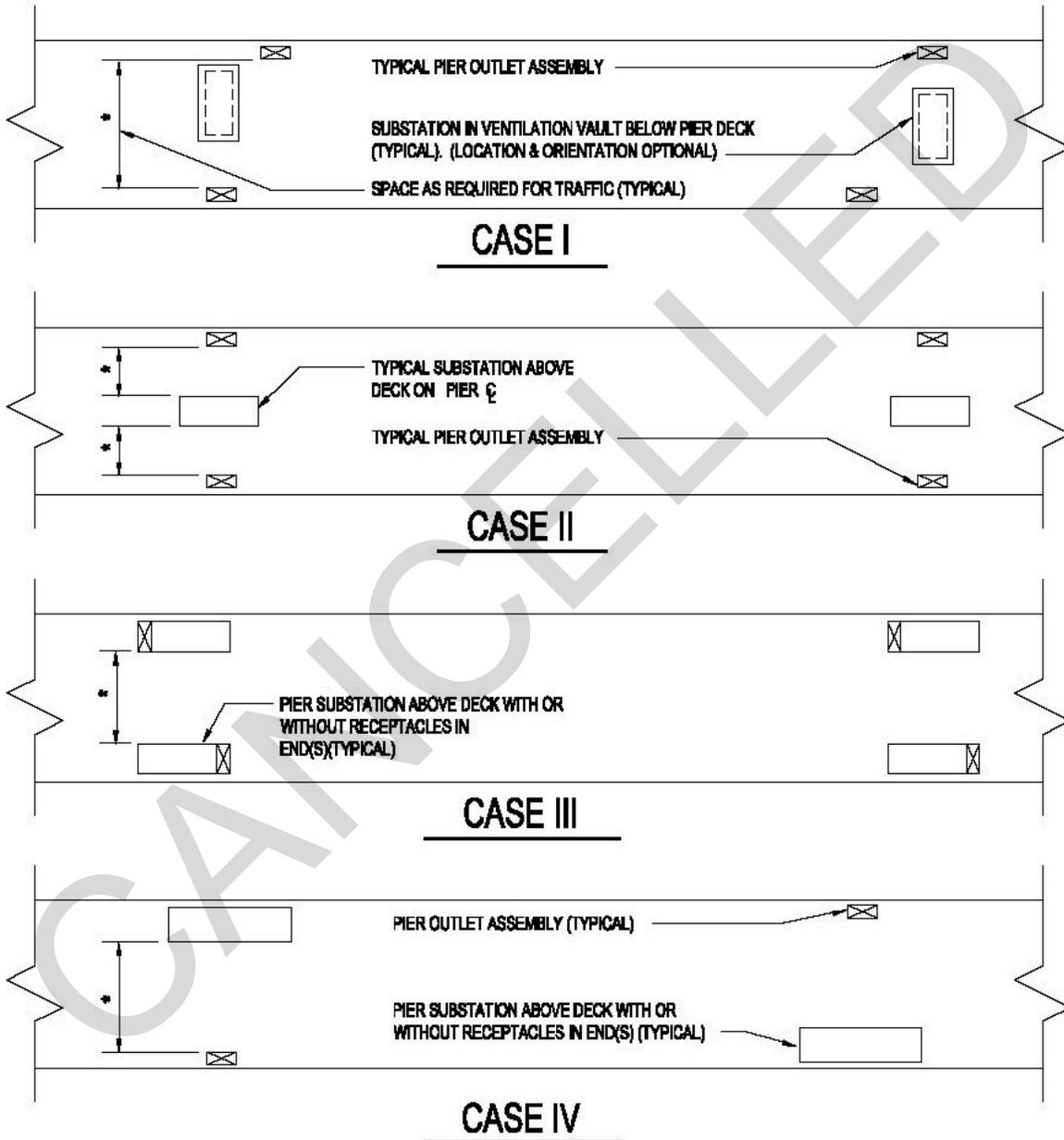
- a) Double-deck Piers. On a double-deck pier, the upper deck is used for conventional pier functions while the lower deck serves utility systems and utility connections. The electrical service for a double deck pier should be a permanent service. The substations should be located on the lower deck and may be symmetrically arranged around the pier centerline. Cross sections of a double-deck pier are shown in Figure 2-2. One recent example of substation arrangement and power distribution system is Pier 6 at the Norfolk Naval Base (NNB). It consists of two electrical service clusters with each service cluster consisting of four 4,000 kVA unit substations,

totaling 32 mVA. The output of these substations serves fixed low voltage outlet assemblies. These outlets are defined on the Pier 6 project drawings as “shore power stations” (SPS). Each SPS contains 12 sets of three, single pole, low voltage cable connectors (36 connectors total) that in turn serve the shore-to-ship service cables. Illustrations of the electrical system for the NNB double-deck Pier 6 are shown in Figure F-1. Pier 6 was designed as a general berthing pier to support all ship classes except SSN and CVN, and may not be directly applicable for double-deck SSN and CVN piers or piers designed for specific ships. See paragraph entitled “Connectors” for additional information on the various types of connectors currently being used.

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Figure 3-18 Typical Alternative Pier Electrical Equipment Arrangements

NOTE:  
LOCATION, SPACING & NUMBER OF SUBSTATIONS & PIER  
OUTLET ASSEMBLIES REQUIRED VARY WITH SITE.



- b. Single Deck Piers. On a single deck pier the substation can be deck mounted or at grade level adjacent to the pier. The unit substation illustrated in the vault system in Figure F-2 could also be utilized in the pier deck mounted or grade level installation system. In either installation method, the unit substations are outdoor construction. The deck mounted/grade level substations may include walk-in aisle features, however they are not recommended when located on the pier due to the significant increase in size.
- c. Existing Pier Vaults. Many existing Pier's utilize the electrical vault system. This system is described in Figure F-2. This type of electrical service, commonly used on many existing piers, is not authorized for the design of new piers without approval from NAVFAC or USACE. It was based upon electrical vaults located below the pier deck that were designed as an integral part of the pier's structural system. The vaults house secondary unit substations and may also contain primary switching equipment. The vaults require proper ventilation, pumping systems, and an access system integrally designed into the pier's deck. This type of electrical system has four significant disadvantages: (1) the vaults are considered to be a "confined space"; (2) the vaults are subject to flooding; (3) the vault's environment is excessively corrosive to the electrical equipment, even under normal conditions; and (4) replacement of a unit substation creates significant interference to pier operations and results in deck pavement removal and replacement.

When a vault system is used, the substation vaults must be ventilated and flood resistant for protection of the electrical equipment. Prevent flooding with dual sump pumps that discharge at a point above highest tide. Provide a "float switch and alarm system" to alert personnel of sump pump failure and high water level. The sump pump power must be connected to a source other than the vault substation. That source must remain energized when the pier electrical hotel service power and permanent / industrial power systems are turned off. Freeze protection must be provided in climates where any element of the pumping system could freeze. Ventilation cooling must be provided with air quantity based upon the highest site temperature and the highest vault temperature that can be tolerated by the electrical equipment. One approved method of vault ventilation is shown in Figure F-2. Separate ventilation air intake and exhaust louvers by as much distance as possible. They may be on opposite sides of the pier if the ventilation ducts are above high tide. Provide an access system for the electrical vault that includes personnel access and equipment replacement access. Personnel access usually consists of manhole frame with cover and vertical ladder. Equipment access systems are a significant structural element that are required to withstand vehicular traffic and must be designed as an integral part of the pier deck.

### **3-8.4.2 Outlet Assemblies.**

The number of electrical shore service stations, their location aboard ship, the per station ampacity, and appropriate voltage for each ship are defined in Appendix C. For a general discussion of methods to be used to establish shore utility station spacing on piers and wharves, refer to Chapter 2. For spacing at drydocks, refer to UFC 4-213-10.

### **3-8.4.3 Cable Lengths.**

Most ships have to be served from multiple 400A circuits. Design the electrical system such that cable lengths from the substation to the outlet assemblies in the parallel circuits are approximately equal (within 10 percent).

### **3-8.4.4 Combined Equipment.**

Electrical substations and outlets may be consolidated in an integral package, with the receptacles placed in the side (or sides) of the substation enclosure. These consolidated outlet assemblies may be spaced as necessary along the pier or drydock perimeter. See Figure 3-18, cases III and IV.

### **3-8.4.5 Outlet Assemblies for Portable Equipment.**

When supplying ships loads from portable substations, locate primary outlet assemblies in the same manner as required for regular outlet assemblies. Primary outlet assemblies, provided for temporary services that supplement permanent substations, should be placed in the vicinity of their intended use. Coordinate these locations with the Activity and the cognizant NAVFAC FEC OR USACE District.

### **3-8.5 Distribution System Equipment and Materials.**

Equipment and materials selected for waterfront electrical systems must be coordinated with the cognizant NAVFAC FEC OR USACE District and the standards and preferences of the Activity. Since significant technical information for many of the distribution system components is available in the Unified Facilities Guide Specifications (UFGS ) Sections UFGS 26 11 16, *Secondary Unit Substations*, UFGS 26 13 00.00 20, *SF6 Insulated Pad-mounted Switchgear* and UFGS 26 23 00.00 40, *Switchboards and Switchgear*, the nomenclature and requirements for the equipment must be thoroughly coordinated in the project documentation (plans and specifications).

#### **3-8.5.1 Fixed Substations for 480 Volts Service.**

There are several methods for providing substations for permanent 480 volts services on piers. Based on the overall system design, the substation should contain primary, secondary, auxiliary, and transformer sections. See Appendix E. The primary section would either contain the primary overcurrent protection features, a disconnect switch, and a service circuit selector switch if the system includes multiple primary circuits, or it would be limited to the primary circuit terminations if separate pad-mounted primary switchgear is used. There must be separate 480 volts secondary unit substations designated for the ships hotel loads and for the other pier loads including industrial power (if required). The main transformers should be of the liquid-cooled type, standard three-phase, 480 volts, with four full-capacity, 2-1/2-percent taps, two above and two

below the nominal primary voltage rating unless actual operational conditions require other tap settings. Maximum transformer rating should be 4000 kVA. Substations, including transformers should be stainless steel with a paint coating system in compliance with ANSI /NEMA C57.12.29. If specific operational conditions require parallel operation with the shipboard generators, coordinate with the cognizant NAVFAC FEC and NAVSEA to determine the additional features that must be added to the equipment. In these cases, the shipboard generator and other equipment ratings are available upon request from NAVSEA.

- a. Shore Power Circuit Breakers. The equipment should provide 480 volts (nominal), three-phase, 60 Hz power, as defined in ANSI/NEMA C84.1, *Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)*, voltage range "A." via low voltage power circuit breakers. The power circuit breakers shall be electrically operated, drawout-type, with adjustable electronic trip features. Feeder circuit breakers shall provide circuit protection up to a maximum overcurrent setting of 480A and interrupting ratings up to 100kA at 480Vac without fuses. Provide a circuit breaker for each individual shore power service receptacle.
- b. Shunt Trip Interlocks.
  - Provide a shunt trip interlock circuit that will affect the opening of all possible paralleled circuit breakers in the event that any shore power circuit breaker trip due to an overcurrent operation.
  - For existing installations, provide a shunt trip interlocking scheme on all ship power service circuit breakers for submarines
- c. Space Heaters. Space heaters should be incorporated within individual substation sections in order to prevent condensation.

### **3-8.5.2 Substations for 4160 or 13,800 Volts Service.**

Provide substations with a secondary voltage of 4160 or 13,800 volts (nominal, as defined in ANSI /NEMA C84.1, voltage range "A"), when required by Appendix C for the classes of ships to be berthed. Design of primary unit substations is similar to fixed 480 volt substations except for voltage classifications and outlet assembly provisions. Circuit breakers should be 5 kV or 15kV vacuum drawout type, with interrupting current rating based on available fault.

### **3-8.5.3 Portable Substations.**

See Figure F-3. The pier design must include space allocation for the portable substations and provide the electrical primary distribution system required to energize the portable substations. This includes primary circuits, their disconnect switches, and

the primary outlet assemblies. Design is similar to fixed substations except for portability provisions.

#### **3-8.5.4 480-Volt Outlet Assemblies.**

480 Volt outlet assemblies (receptacles and cable connections) vary with Activities but should be standardized on a Station-by-Station basis. Additional information on the outlet assemblies and the actual operational procedures used on the piers is available in UFC 3-560-01, *Electrical Safety O&M*, Section 9, "Shore-to-Ship Electrical Power Connections". Detailed specifications for the outlet assemblies are also included in guide specification UFGS 26 05 33, *Dockside Power Connection Stations*.

Receptacles. Ships hotel service receptacles must be provided in weatherproof, corrosion-resistant pier outlet assemblies, or combined with the substations. Provide the number of receptacles required to serve the specific ship types and classes in accordance with Appendix C. There are currently two types of ships' hotel service receptacles being used. Many existing facilities utilize a three pole, 500 amp receptacle in accordance with Mil Spec MIL-C-24368/1, *Connector Assemblies; Plug, Power Transfer, Shore to Ship and Ship to Ship*. A typical MIL-C, three-pole outlet assembly is illustrated in Figure F-4. Other facilities utilize a single-pole, 500 amp receptacle, grouped in a cluster of three. Typical details of the single-pole receptacle system are shown in Figure F-5.

#### **3-8.5.5 Primary Outlet Assemblies.**

Primary voltage outlet assemblies must have weatherproof, corrosion-resistant enclosures and high voltage connectors. Connectors must match the standard primary voltage coupler in use by the Activity and as required by the cognizant NAVFAC FEC OR USACE District. Disconnects should have an interlocking key which can only be removed when the switch is opened. Design should be such that, after the disconnect has been opened, the interlocking key must be used to unlock and make possible the insertion or removal of the corresponding primary voltage pier coupler plug. Provide 500 amp coupler receptacles at each 4160 and 13800-volt pier outlet assembly. Incorporate outlet assemblies into substations as applicable. See Figure F-6 for typical 15 kV details.

#### **3-8.5.6 Coordination of Shipboard Phase Rotation.**

Shipboard alternating current systems have a standard phase rotation. To minimize the phasing procedure and to reduce the time required to connect shore-to-ship power cables, shore power connectors should be phased so that they are compatible with the shipboard system. Refer to NAVSEA 59300-AW-EDG-010/EPISM, Section 2, Group E, Sheets 14 and 15, to determine phase rotation required for shore power connections.

#### **3-8.5.7 Conduit Systems.**

For electrical conduit exposed under or on a pier, wharf, or drydock, evaluate the relative advantages of Schedule 80 PVC, and fiberglass-reinforced epoxy conduit. Avoid the use of PVC where they will be exposed to sunlight and moving objects.

Although PVC Coated steel conduits have been used on many piers, the alternatives are more attractive economically and from a durability standpoint. The potential exists for loss of integrity of the PVC Coating systems in the harsh and corrosive environment. Fiberglass cable trays may be used in lieu of conduit where adequately protected from physical damage and the elements. Provide stainless steel or fiberglass hangers and bolts. Coordinate with the requirements in paragraph 2-4.1.3.

### **3-8.6 Ships' Shore Power Requirements.**

Appendix C provides a listing of shore electrical loads of ships while homeported or undergoing alteration and repair. Substation and feeder sizing on piers and wharves must be based upon the electrical loads given in the "Design Load" for the largest ship (or largest number of ships) of all classes which could be berthed at the pier. The minimum number of receptacles provided in a secondary outlet assembly should match the number of receptacles in the ship's respective receptacle stations. Nested ships must also be considered in the electrical outlet assembly design where indicated by the facility berthing plan or where conceivable at a future date.

#### **3-8.6.1 Alternating Current Power.**

Hotel service loads include the ship's electronics, weapons systems, cargo booms, galley equipment, space heating, and miscellaneous lighting and power loads. The number of circuits shall be as requested by ship's force. These loads are supplied with either 480 volts (nominal) or 4160 volts (nominal) ungrounded power, or 13,800 volts (nominal) ungrounded power. The 480 volts system shall supply approximately 480 volts at no load and 450 volts (plus or minus 5 percent) under loaded conditions and at the ship's load center. The 4160 volt system shall supply approximately 4160 volts plus or minus 5 percent under loaded conditions and at the ship's load center. The 13,800 volt system shall supply approximately 13,800 volts plus or minus 1 percent under loaded conditions. Cable ratings must be sized to exceed the ships' loading requirements of Appendix C and the associated circuit breaker trip settings. System design must be coordinated with the planned nesting requirements of the pier to maintain the voltage within the allowable tolerances at outboard ships.

#### **3-8.6.2 Direct Current (dc) Power.**

When required, dc power should be provided for certain ships in accordance with instructions provided by the Activity. Portable rectifier units will be provided by the Activity. Provide sufficient ac power and receptacles to serve such equipment. Coordinate connection requirements with the Activity.

#### **3-8.6.3 400-Hz Power.**

400-Hz power for ship service may be supplied from the 480 volts system utilizing portable generating equipment furnished either by the Activity or by the ship. Provide 60 Hz power and receptacles to serve such equipment. Coordinate connection requirements with the Activity.

#### **3-8.6.4 Shipboard Equipment Ratings.**

Most ship distribution circuit breakers operate at 440 volts and are protected with 100,000-amp, current-limiting fuses in series with the breakers. In most cases, these circuit breakers are type AQB-LF400 as described in NAVSHIPS Publication 362-2333, *Air Circuit Breakers (Fused), Navy Type AQB-LF400*. The main breaker for the shipboard system on nuclear carriers is an air-type breaker rated at 250,000 amps asymmetrical interrupting capacity, and without current-limiting fuses. The shore distribution system must be designed in accordance with UFC 3-501-01, *Electrical Engineering*, to ensure that available fault is within the capability of the ship's distribution system. Contact the cognizant NAVFAC FEC OR USACE District for information on shoreside fault current data to determine the required interrupting capacities and equipment design characteristics.

### **3-8.7 Supplemental Requirements for Nuclear Submarines (SSN, SSBN).**

Nuclear submarines (SSN, SSBN) should conform to the following shore power requirements.

#### **3-8.7.1 Substations for 480 Volts Service.**

Substations serving hotel loads at submarine piers must be designed in accordance with paragraph 3-8.5.1 for fixed substations, or paragraph 3-8.5.3 for portable substations, and in accordance with the supplemental requirements below. The substation's primary section should be built with dual primary feeders. Switchgear and breaker equipment should be designed so that automatic reset and restoration of power to submarine services will be delayed a minimum of 5 to 10 seconds after loss of commercial power. This is required in order to prevent damage to the submarine's electric plant equipment. The maximum time to restore power should be 5 minutes. Provide undervoltage and underfrequency relays at substations. Relay types and set points for undervoltage and underfrequency should be evaluated separately for each installation and coordinated with the cognizant NAVFAC FEC OR USACE District.

#### **3-8.7.2 Standby Power.**

Power requirements for normal operation are given in Appendix C. Emergency backup power to the normal shore supply is required. An emergency backup electrical power source for the reactor plant is required which is capable of providing 440 Volt, 3 Phase 60 Hz power with a capacity of at least 850 kW with the ability to start a 260 HP induction motor with an initial load of 650 kW. The emergency backup power source should use the normal ship's shore power connections. This source of emergency power will only be required to be available when power from the ship's battery or diesel generator are not available. The emergency backup power source can be, for example, a portable generator set, or separate power sources to the facility, provided that the loss of one source will not result in a long duration power outage.

#### **3.8.7.3 Maximum Downtime.**

For the shore facility and overhaul yard drydock permissible outage time allowed is 5 minutes. System downtime is defined as: (1) the time required to restore power to the pier when maintenance or repair activities are required; or (2) the time required to

transfer from one power source to another after system disturbances. This includes the time required for protective devices to operate and the time to start emergency generators.

#### **3-8.7.4 Super Shore Power.**

Appendix C lists “super shore power” requirements for nuclear submarines. Super power is required for the ship’s testing, checkout, and refueling operations. These super shore power requirements are in addition to the normal power requirements. Provide super power from a separate substation that supplies no other loads. Portable substations connected to temporary service outlets are recommended for this service. Extend primary service and provide connections for these portable substations. The special requirements for submarine piers given in subparagraphs 3-8.10.1, 3-8.10.2, and 3-8.10.3 above do not apply to super shore power.

#### **3-8.8 Ground System.**

Provide a ground system at piers, wharves, quaywalls, and other waterfront structures that measures not more than 5 ohms for all permanent electrical equipment. Ground systems should be in accordance with NFPA 70. Stranded-copper-wire ground conductors, sized in accordance with NFPA 70, should be used to interconnect equipment enclosures and the ground system.

#### **3-8.9 Pier Lighting.**

Information on pier lighting is available in UFC 4-152-01, *Design: Piers & Wharves*.

#### **3-8.10 Lightning Protection.**

Provide lightning protection systems when required. Coordinate with the cognizant NAVFAC FEC OR USACE District. Design in accordance with MIL-HDBK-1004/6, *Lightning Protection*, and NFPA 780, *Standard for the Installation of Lightning Protection Systems*. Consider the protection of cranes, above deck substations, pier mounted buildings, and lighting system masts.

/4/

### **3-9 TELECOMMUNICATION SYSTEMS.**

The purpose of this section is to provide requirements for Base Level Information Infrastructure (BLII) Pier Connectivity Specifications, telephone service, and other telecommunications systems.

#### **3-9.1 BLII Pier Connectivity.**

These guidelines are provided for planning, designing, engineering, and constructing new or repairing existing Navy piers. Figure 3-19 illustrates the three major components that are required to provide end-to-end connectivity to IT-21 compatible ships. They are the Pier Head ITN Building Node; the Pier Fiber Distribution Center, and the Fiber Optic Riser Panels.

##### **3-9.1.1 Pier Head ITN Building Node.**

The Pier Head ITN Building Node is connected to the Base Area Network (BAN) and becomes the interface for adding additional piers to the infrastructure for SIPRNET/NIPRNET connectivity. At the time this document was prepared, Pier Head ITN Building Nodes have been installed or are in the process of being installed at the following activities: Naval Station Mayport, Submarine Base Kings Bay, Weapons Station Earle, Submarine Base New London, Naval Station Little Creek, and Naval Station Norfolk. Other stations will be added as the Navy Marine Corps Internet (NMCI) comes on line. A 144-strand hybrid fiber optic cable (72 multi mode and 72 single mode) is required between the Pier Head ITN Building Node and the Pier Fiber Distribution Center. This cable may already exist if the pier is being repaired; however, for new pier construction, the cable will need to be installed. The designer should coordinate with the local Information Technology (IT) group to ensure that the proper Pier Head ITN Building Node has been identified. All cabling and interconnections inside the Pier Head ITN Building Node are the responsibility of the local IT group unless other prior arrangements have been made.

### **3-9.1.2 Pier Fiber Distribution Center.**

The Pier Fiber Distribution Center provides a breakout point for the 144-strand hybrid fiber optic cable coming from the Pier Head ITN Building Node and the Fiber Optic Riser Panels. Figure 3-20 shows the fiber optic cable entering into the splice can from the Pier Head ITN Building Node. The fiber is spliced onto another 144-strand fiber optic cable (72MM/72SM) for submarine piers or 96-strand fiber optic cable (48MM/48SM) for surface ship piers. This is routed to the Environmental Distribution Center 1 (EDC 1) patch panel. Using internal patch cables, EDC 1 is patched to EDC 2. From EDC 2, a 144 or 96 strand hybrid fiber optic cable is routed to a second splice can where it is spliced to several 24-strand hybrid fiber optic cables (12MM/12SM) that run to the Fiber Optic Riser Panels. Figures 3-21 through 3-24 provide detailed information on the EDC 1 and EDC 2 patch panels located inside the Pier Fiber Distribution Center and their interconnections. (Note that the patch panels are shown for both surface ship piers and submarine piers).

### **3-9.1.3 Fiber Optic Riser Panel.**

The Fiber Optic Riser Panel is the interface for the ship to shore connectivity. The panel is provided with a 24-strand hybrid fiber optic cable (12MM/12SM) coming from the Pier Fiber Distribution Center. This provides a fiber optic receptacle, J1, to interface with the umbilical cable assembly that goes to the ship (note that details on the J1 pigtail assembly may be found on NAVSEA drawing 7325760D). Figure 3-25 shows the Fiber Optic Riser Panel. Figures 3-26 and 3-27 show the patch panel connections inside the EDC for a surface ship and submarine respectively. Figures 3-28 and 3-29 show the rubber gasket cutouts for a surface ship and submarine respectively.

### **3-9.2 Telephone Systems.**

Provide a voice telephone distribution system to each berth on piers and at drydocks unless specifically instructed otherwise. Provision should be made for the telephone cable to be terminated in a telecommunications outlet assembly adjacent to each berth.

Provide a Main Distribution Frame (MDF) at the shore end of the pier for the cross-connect devices. The assembly must include connectors mounted to the exterior of the enclosure. These connectors will be connected to the shore end of the ship-to-shore telephone cable. Commercial "dial tone" services and the telephone switching system is the responsibility of the Station's Communications Officer.

### **3-9.2.1 Ships Demand.**

Appendix C identifies the number of telephone pair shorelines required by each ship type. Cable sizes include the ship requirement, the appropriate embarked-staff requirement, and an allowance for spare pairs. Cable sizes have been rounded up to the next larger standard telephone cable. The pier telephone distribution cable system should be designed using the pier's berthing plan. Provide cable sizes based upon the worst case at each berth. Berths designed for nested ships should be provided with the total number of cables indicated for all ships in the nest.

### **3-9.2.2 Other Demand.**

Provide telephone service to security checkpoints and watchstand stations. These requirements may occur at the head and end of the pier, and at intermediate points along the pier. Coordinate with the Activity's security representatives.

### **3-9.2.3 Coin-Operated Telephones.**

When required, provide an independent conduit system to serve a vendor installed telephone cable which serves shipboard coin-operated telephones. Unless instructed otherwise, provide a conduit system at the head of the pier to support coin-operated telephones ashore (also to be vendor operated).

### **3-9.2.4 Location and Arrangement of Pier Telephone Distribution System.**

Each berth should be served by an independent run of conduit. The telecommunications outlet assembly must be an independent, freestanding structure. Outlet assemblies must be designed to prevent damage by ships lines and by traffic on the pier.

### **3-9.3 Other Telecommunications Systems.**

The need for the systems described below should be evaluated on a site-by-site basis. Provide these systems as directed by the Activity and the cognizant NAVFAC /4/ FEC /4/ OR USACE DISTRICT.

#### **3-9.3.1 Dedicated Communication Circuits.**

Provide one 2 in (50.8 mm) conduit from the manhole or cross-connect cabinet at the head of the pier to each telecommunications outlet assembly. This conduit must be dedicated for communication circuits that cannot use the telephone system.

#### **3-9.3.2 Cable Television.**

Provide a conduit system (from the manhole at the head of the pier to each telecommunications outlet assembly) to support cable television requirements. Unless instructed otherwise, the cable television system will be provided by a commercial vendor. The designer must coordinate with the vendor and provide a complete raceway system.

### **3-9.3.3 Alarm and Signal Circuits.**

Provide two 1-1/4 in (31.7 mm) conduits (from the manhole at the head of the pier to each telecommunications outlet assembly) to serve alarm and signal circuits that cannot use the telephone system. Provide all conductors to serve these systems unless instructed otherwise. Coordinate with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT.

## **3-10 PIER POWER METERING SYSTEMS.**

Naval ships connected to shore power utilize a large percentage of the Navy's infrastructure electricity. Many bases are now requiring the electricity usage to be measured and recorded. Since multiple circuits are normally used to provide the required capacity to the ships, often in a "nested" configuration, standard metering/ monitoring equipment may not be appropriate. There are however, commercial and government developed systems, including hardware and software that are available. Coordinate with the cognizant \4\ FEC /4/ to determine if the Activity has a desired or required system that must be utilized.

### **3-10.1 Pier Power Monitoring System (PPMS).**

One of the power measurement systems available has been developed by the Naval Facilities Engineering Service Center (NFESC). The system is defined as the PPMS and consists of specialized embedded computer circuit boards, embedded software, and personal computer (PC) software that enable the Activity to measure, record, and study the electricity consumption and usage patterns of the connected ships. The PPMS was developed to be cost effective and to be easily installed. It involves the simple utilization of a conventional utility metering system. Typically, each monitored electrical outlet assembly will have one set of circuit boards. Battery backup features ensure that no data or operating software is lost when electrical power is disconnected. The data are sent to a central PC station. The PC can program the circuit boards and retrieve data. Parameters available on the PC are megawatt-hours and instantaneous values of amps, volts, power factor, and megawatts. Time-of-use (TOU) data are also available for the present 24-hour period. The PPMS correctly identifies the receptacles allocated to each ship and the total power consumed. Both the ship (customer) and the Activity (provider) can easily track shore supplied ship electricity. Software can be easily tailored to send the data directly from the PPMS to a master data collection and billing system. By providing complete energy use pattern information and consumption data, the PPMS enables Navy managers to educate, monitor, and encourage energy conservation for ships using shore supplied electricity. An operating PPMS demonstration system is presently installed on Pier 1 at Naval Station San Diego, CA.

**3-11 OTHER SERVICES.**

Although their design is not covered by this UFC other services will occasionally be required at active and repair berthing facilities. Such systems include: jet fuel, chilled water, pure water, oxygen, acetylene, mapp gas, and inert gases. These services may be permanent or temporary (tank truck, gas containers or similar means) depending upon required quantity, location and economic considerations. The designer must consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for specific instructions.

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Figure 3-19 Block Diagram of Pier Structure

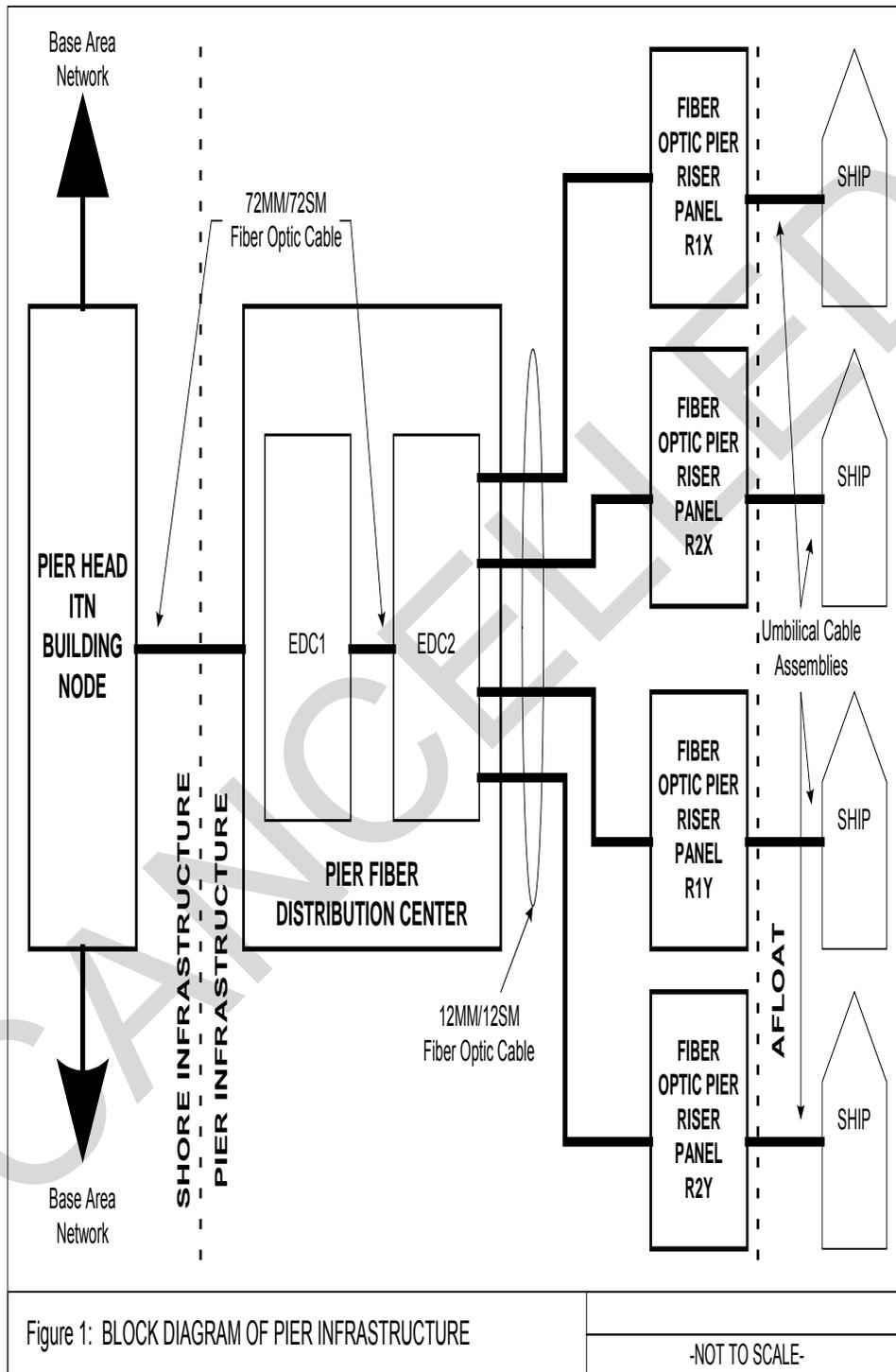


Figure 3-20 Pier Fiber Distribution Center

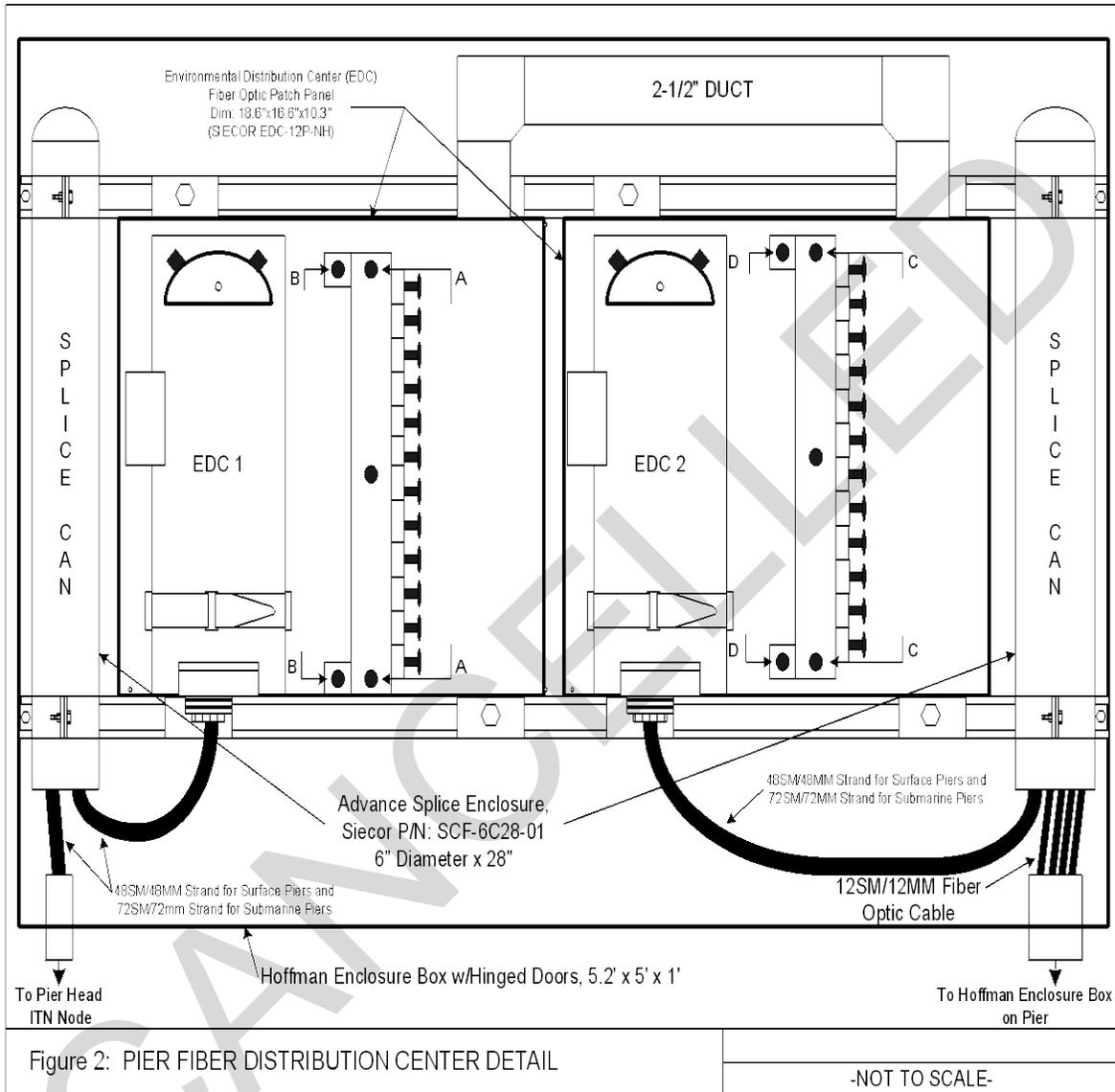


Figure 3-21 Pier Fiber Distribution Center EDC 1 Rear Detail Surface Pier

	1	2	3	4	5	6
A	F1 MM-X-A1	F3 MM-X-A2	F5 MM-X-A3	F7 MM-X-A4	F9 MM-X-A5	F11 MM-X-A6
	F2 MM-X-A1	F4 MM-X-A2	F6 MM-X-A3	F8 MM-X-A4	F10 MM-X-A5	F12 MM-X-A6
B	F13 MM-X-B1	F15 MM-X-B2	F17 MM-X-B3	F19 MM-X-B4	F21 MM-X-B5	F23 MM-X-B6
	F14 MM-X-B1	F16 MM-X-B2	F18 MM-X-B3	F20 MM-X-B4	F22 MM-X-B5	F24 MM-X-B6
C	F25 MM-X-C1	F27 MM-X-C2	F29 MM-X-C3	F31 MM-X-C4	F33 MM-X-C5	F35 MM-X-C6
	F26 MM-X-C1	F28 MM-X-C2	F30 MM-X-C3	F32 MM-X-C4	F34 MM-X-C5	F36 MM-X-C6
D	F37 MM-X-D1	F39 MM-X-D2	F41 MM-X-D3	F43 MM-X-D4	F45 MM-X-D5	F47 MM-X-D6
	F38 MM-X-D1	F40 MM-X-D2	F42 MM-X-D3	F44 MM-X-D4	F46 MM-X-D5	F48 MM-X-D6
E	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
F	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
G	F1 SM-X-G1	F3 SM-X-G2	F5 SM-X-G3	F7 SM-X-G4	F9 SM-X-G5	F11 SM-X-G6
	F2 SM-X-G1	F4 SM-X-G2	F6 SM-X-G3	F8 SM-X-G4	F10 SM-X-G5	F12 SM-X-G6
H	F13 SM-X-H1	F15 SM-X-H2	F17 SM-X-H3	F19 SM-X-H4	F21 SM-X-H5	F23 SM-X-H6
	F14 SM-X-H1	F16 SM-X-H2	F18 SM-X-H3	F20 SM-X-H4	F22 SM-X-H5	F24 SM-X-H6
J	F25 SM-X-J1	F27 SM-X-J2	F29 SM-X-J3	F31 SM-X-J4	F33 SM-X-J5	F35 SM-X-J6
	F26 SM-X-J1	F28 SM-X-J2	F30 SM-X-J3	F32 SM-X-J4	F34 SM-X-J5	F36 SM-X-J6
K	F37 SM-X-K1	F39 SM-X-K2	F41 SM-X-K3	F43 SM-X-K4	F45 SM-X-K5	F47 SM-X-K6
	F38 SM-X-K1	F40 SM-X-K2	F42 SM-X-K3	F44 SM-X-K4	F46 SM-X-K5	F48 SM-X-K6
L	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
M	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK

Figure 3: PIER FIBER DISTRIBUTION CENTER EDC 1  
B-B REAR DETAIL - SURFACE PIERS

-NOT TO SCALE-

Figure 3-22 Pier Fiber Distribution Center EDC 1 Rear Detail Submarine Pier

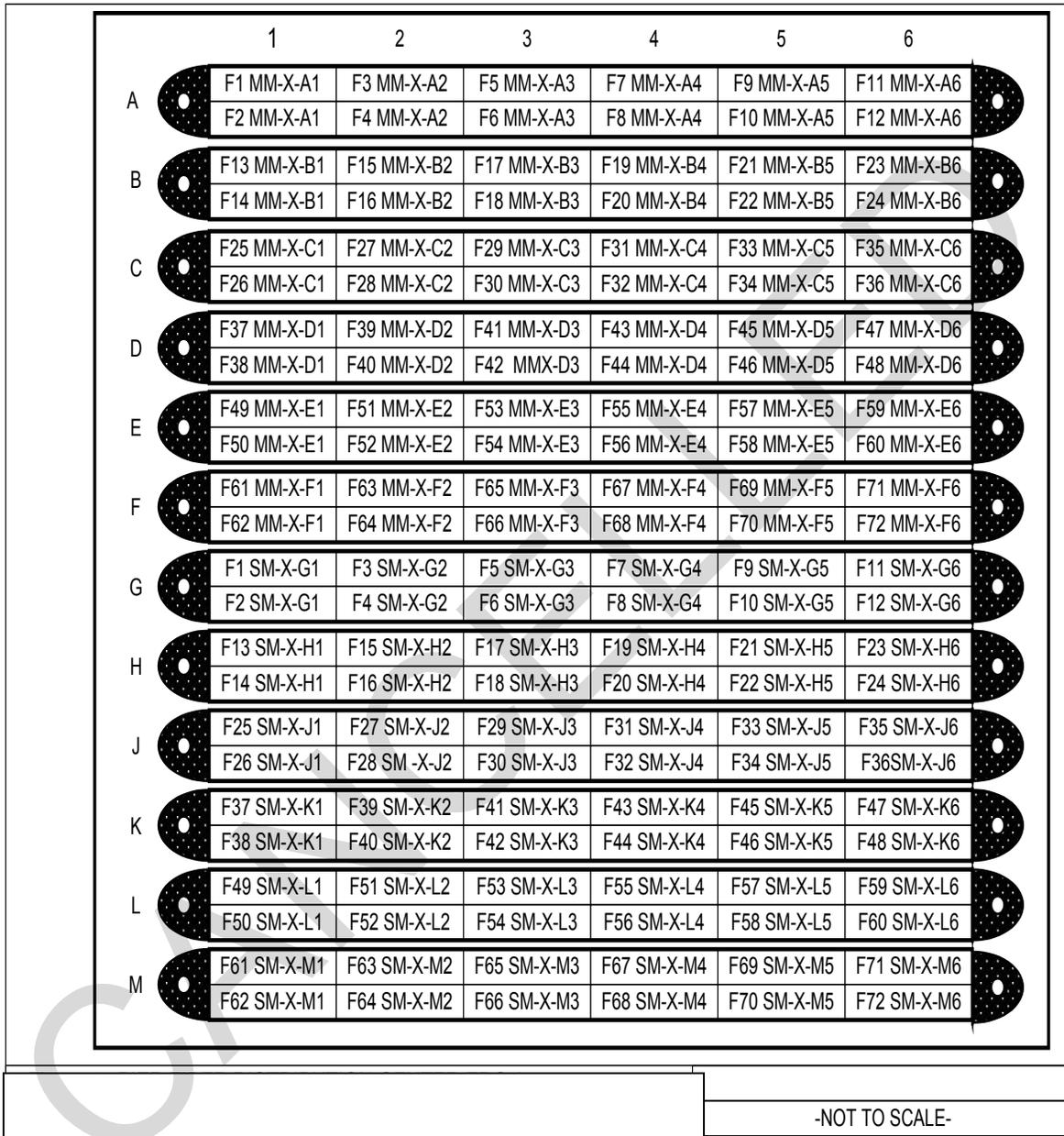


Figure 3-23 Pier Fiber Distribution Center EDC 1 Front Detail Surface Pier

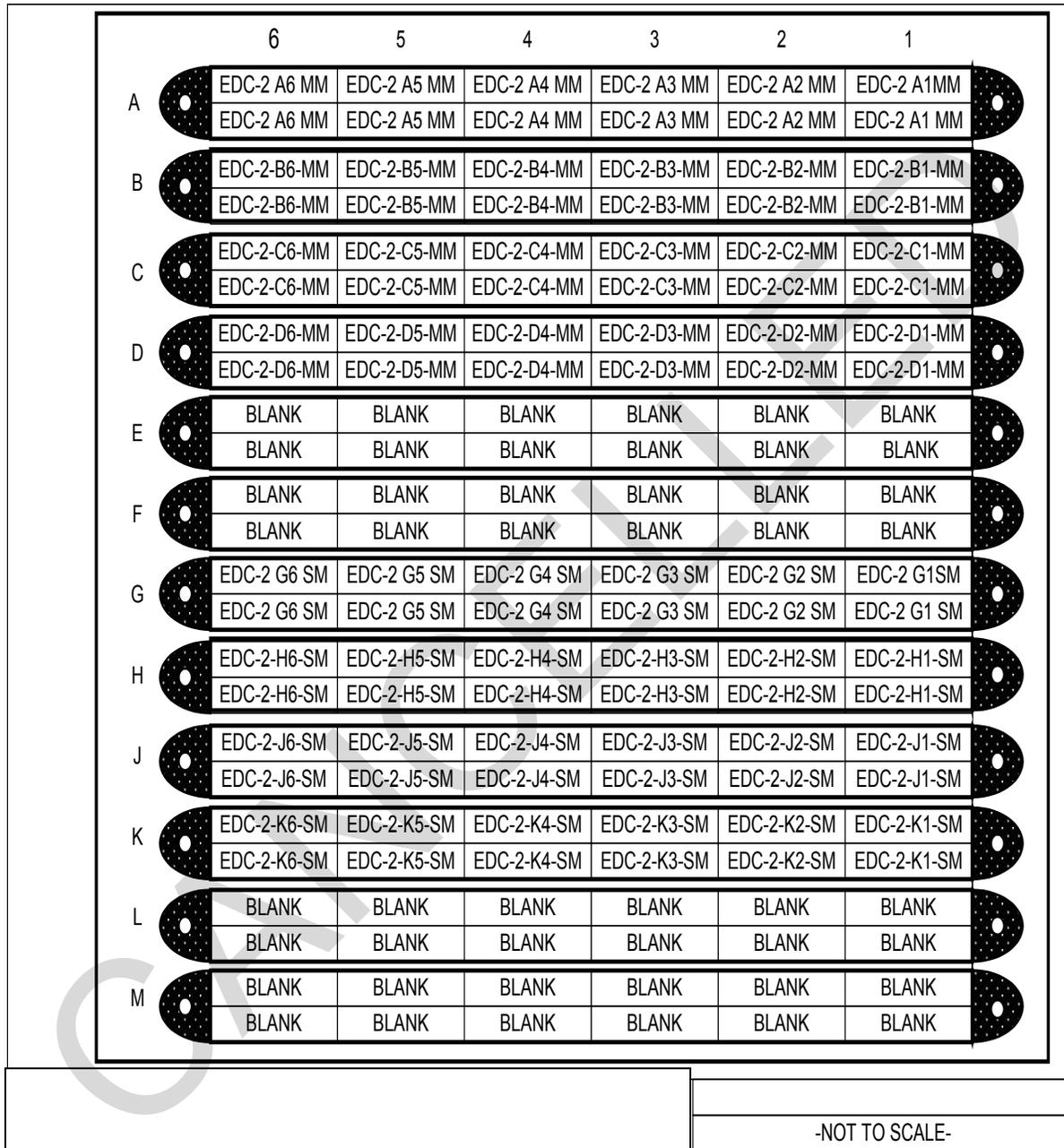


Figure 3-24 Pier Fiber Distribution Center EDC 1 Front Detail Submarine Pier

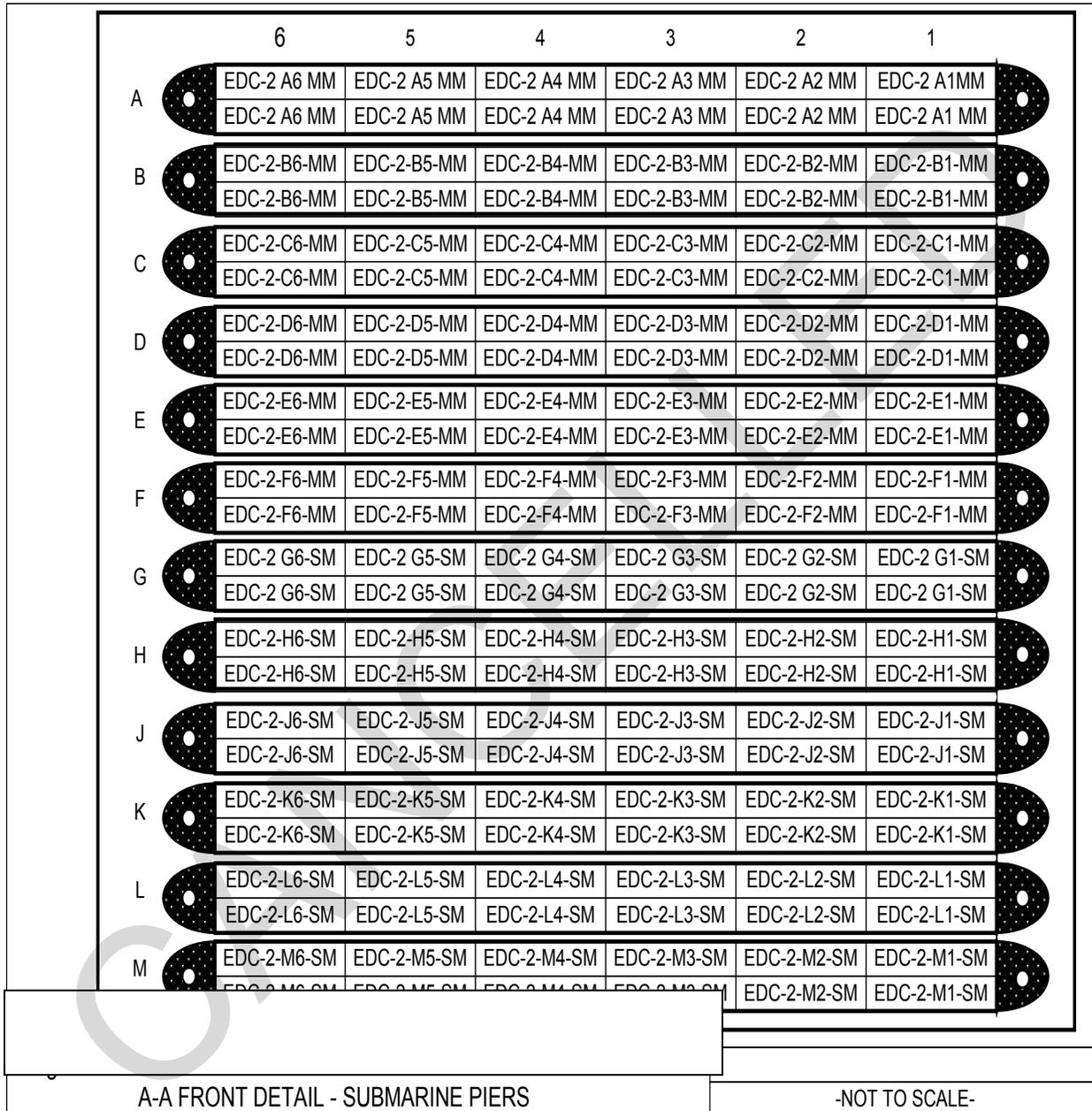


Figure 3-25 Fiber Optic Connectivity Riser Panel Detail

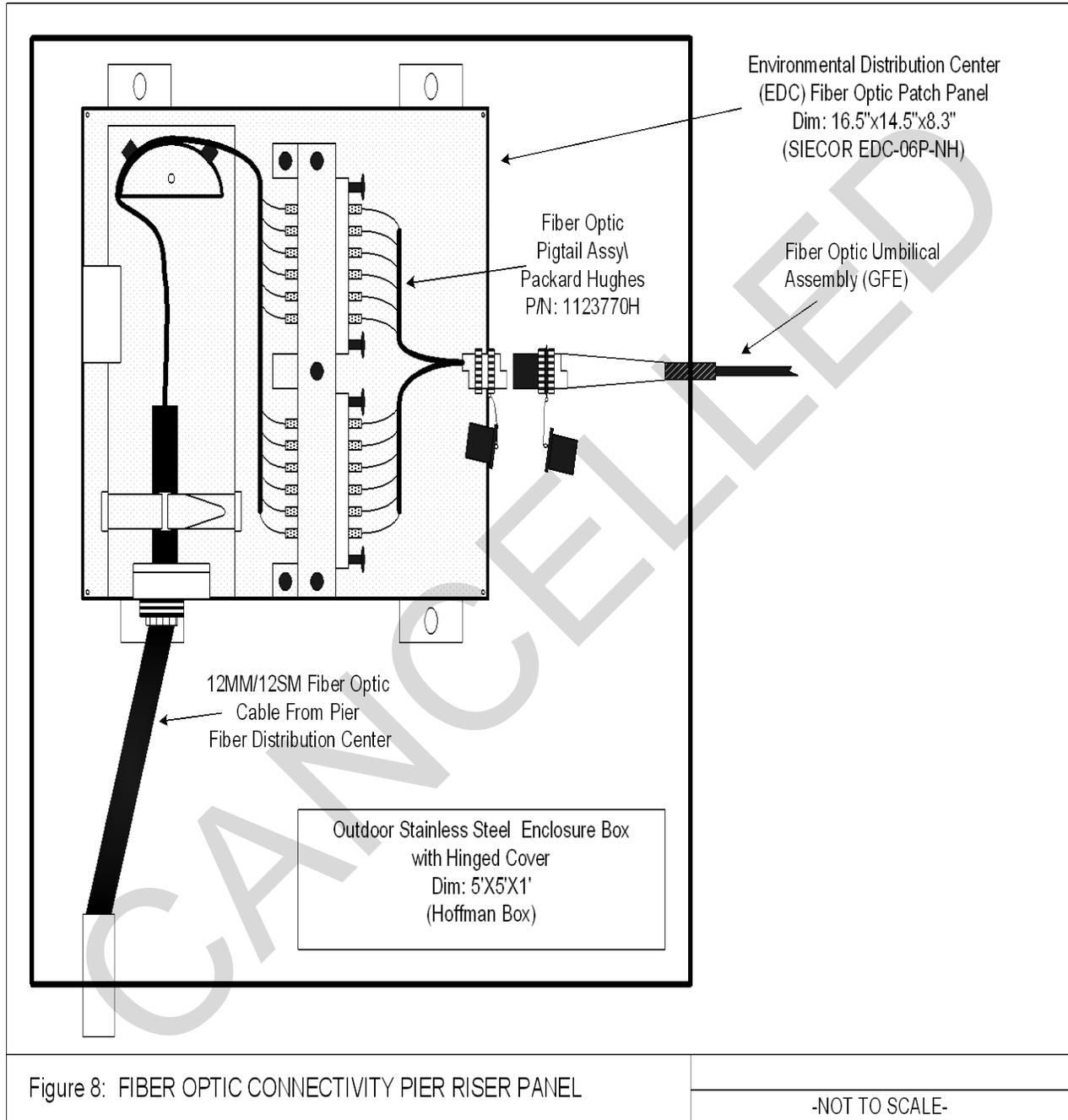


Figure 3-26 EDC Fiber Optic Patch Panel Surface Pier

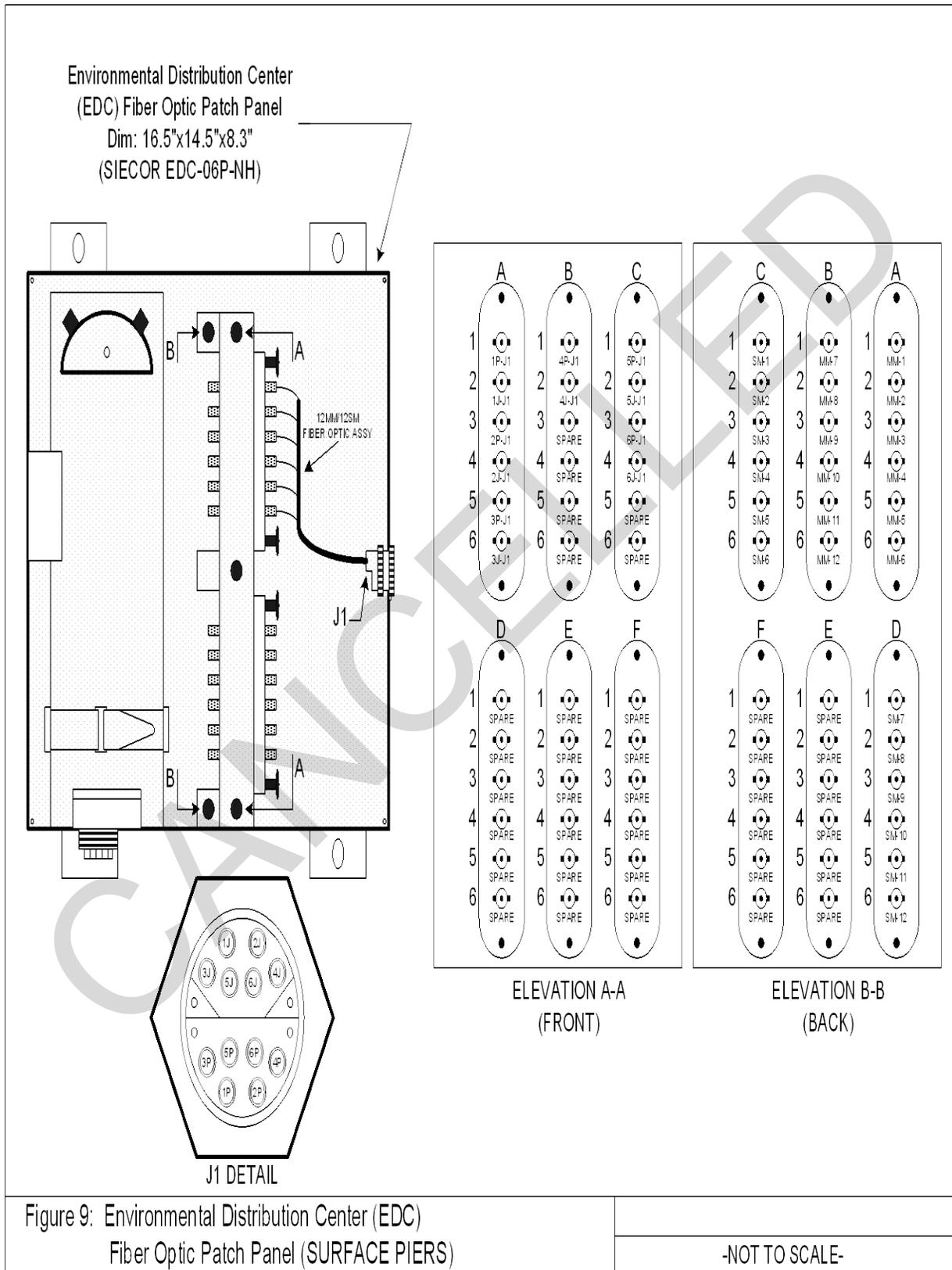


Figure 3-27 EDC Fiber Optic Patch Panel Submarine Pier

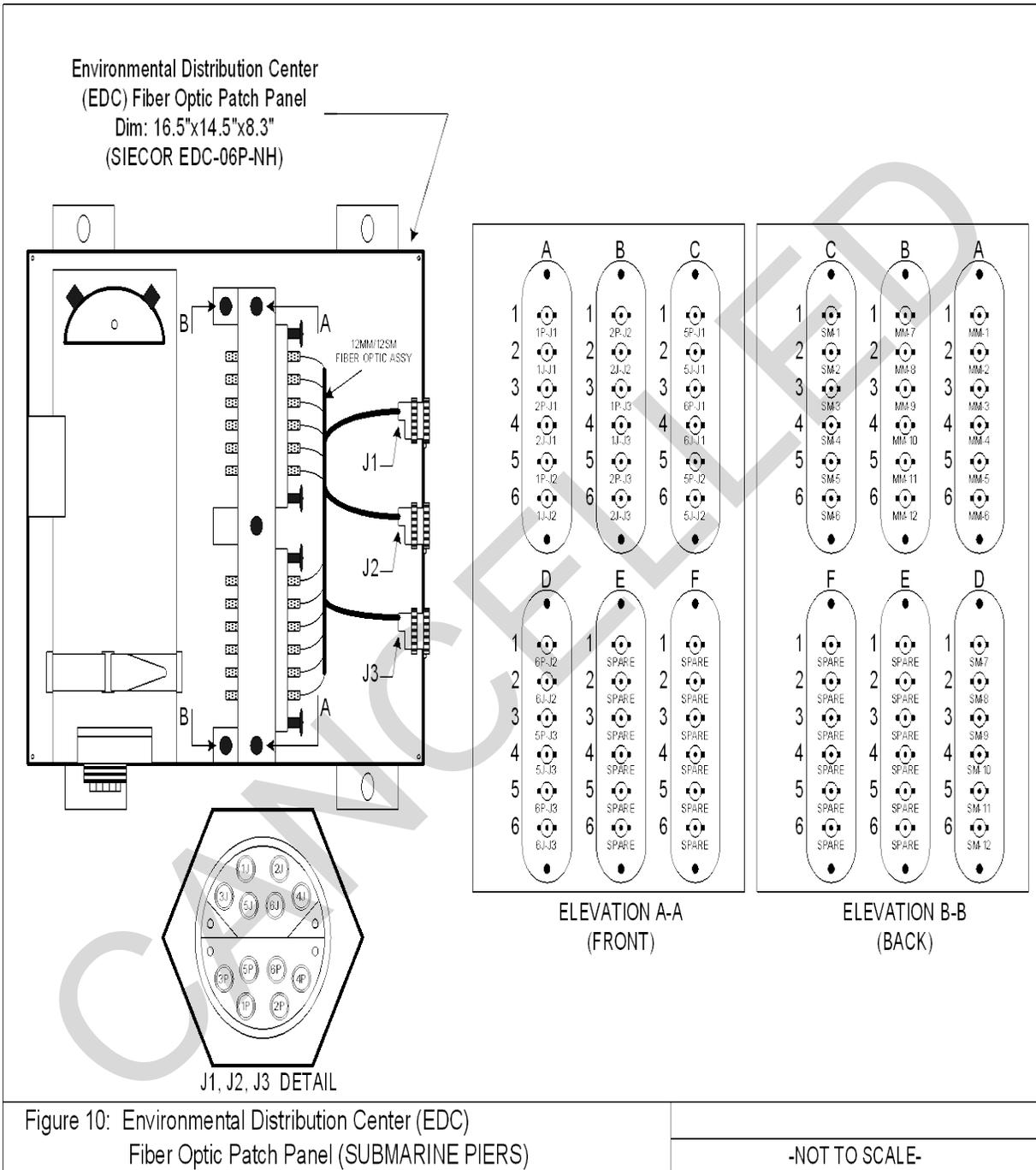


Figure 3-28 Rubber Gasket Cutout Surface Pier

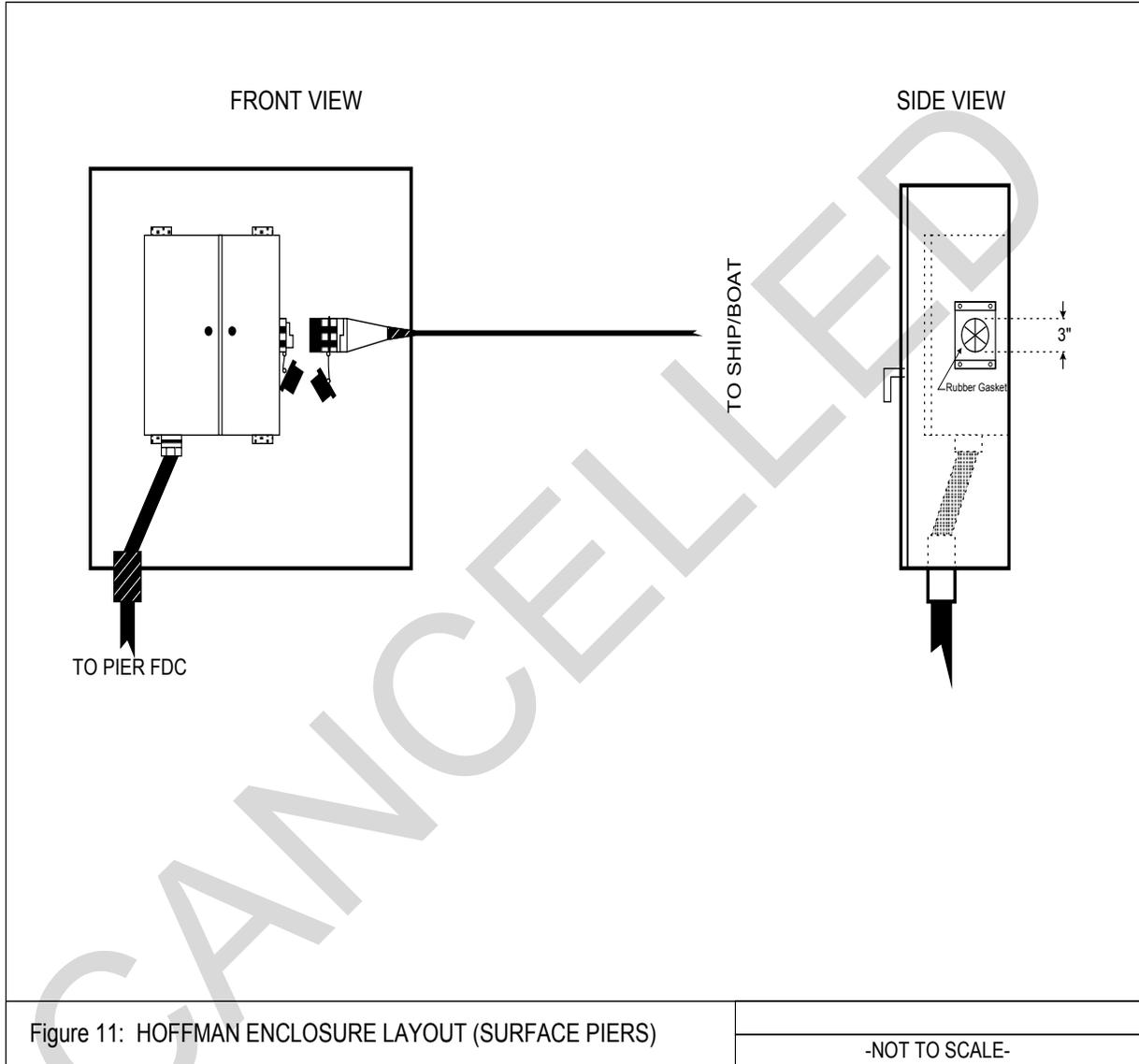
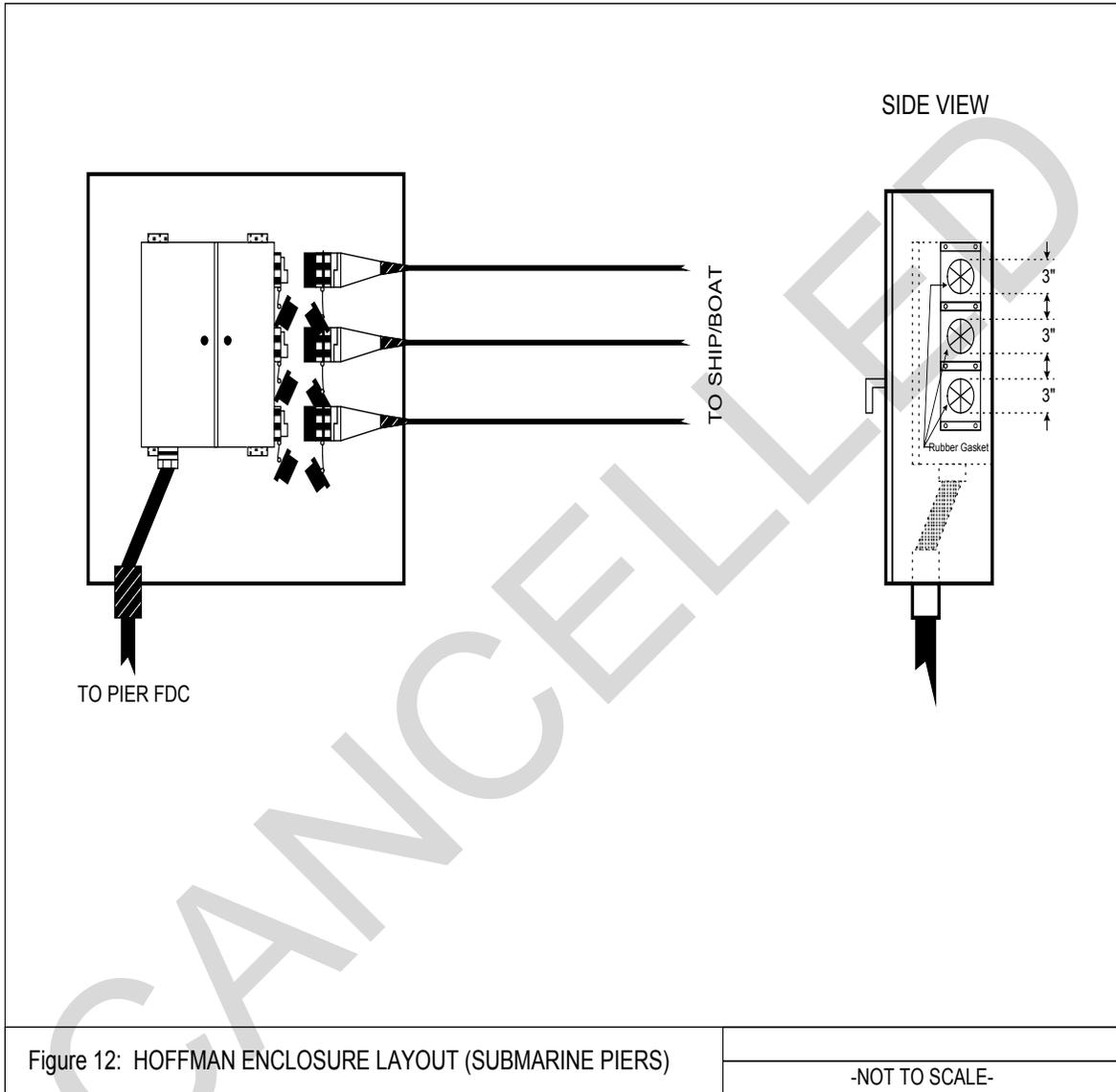


Figure 3-29 Rubber Gasket Cutout Submarine Pier



## CHAPTER 4 SUPPLY AND AMMUNITION PIERS

### 4-1 STEAM AND COMPRESSED AIR.

In general, steam and compressed air services are not required on supply and ammunition piers. However, ammunition piers that serve ballistic submarines require special considerations. See paragraph 4-7.

### 4-2 SALTWATER AND NONPOTABLE WATER.

Provide fire protection water as required for active berthing facilities. However, consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT regarding ammunition piers that are in an isolated area and are far removed from mobile fire apparatus. For remote ammunition piers, design a pumping station to supply between 2500 and 3500 gpm (9,463 and 13,248 lpm) at sufficient pressure to provide 75 psig (517 kPa) residual pressure at the most remote outlet. Outlet connection threads must be national standard male hose threads unless required otherwise to serve an existing system.

### 4-3 POTABLE WATER, SEWER, AND OILY WASTE.

For supply piers, requirements are the same as those for active berthing facilities. For ammunition piers, provide potable water only when indicated in the project directive. However, oily waste and sewer collection systems should always be provided. For all three systems, see the requirements defined in Chapter 3.

### 4-4 ELECTRICAL SERVICE.

Shore power for ships hotel service, lighting, and power for industrial services (as required) will be provided on ammunition piers and wharves that load missiles for nuclear powered vessels. This provision lengthens the life of vessel reactors and decreases manpower requirements during the loading / unloading operation. Electrical systems provided on ammunition piers must be designed for the hazardous rating actually encountered and in accordance with NFPA 70.

### 4-5 TELECOMMUNICATION SYSTEMS.

Both supply piers and ammunition piers require telecommunication systems. However, full services that are defined for active and repair berths are not required except for ammunition piers that serve ballistic submarines. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for specific requirements. In general, the design guides for active and repair berths are applicable. The systems required are to be evaluated on a project-by-project basis. Lastly, comply with all hazardous requirements associated with ammunition piers.

## CHAPTER 5 FUELING PIERS

### 5-1 STEAM AND COMPRESSED AIR.

In general, steam and compressed air services are not required on fueling piers.

### 5-2 SALTWATER AND NONPOTABLE WATER.

Ships loading or unloading POL products at fueling piers will never be cold iron and will therefore not require a shore-to-ship fire protection water connection.

### 5-3 POTABLE WATER, SEWER, AND OILY WASTE.

Supply potable water systems at locations where connections may be made to existing systems. Maximum potable water requirements are 1,000 gpm (3,785 lpm) with 40 psi (276 kPa) residual pressure at the most remote outlet. Design outlets as for active berthing and space about 200 ft (61 m) apart. Provide oily waste and sewage collection systems at all fueling piers unless instructed otherwise. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT. Provide all three systems in accordance with the criteria defined in Chapter 3.

### 5-4 POL SYSTEMS.

Refer to \4\ UFC 3-460-01, *Design: Petroleum Fuel Facilities /4/* for information on piping and other appurtenances, including manifolds, hoses and shelters, connections and adapters, hose handling equipment, bilge and ballast lines, stripper pumps, environmental protection, and other equipment. In general, ships use a 6-in (152.3 mm) commercial flanged connection. Verify before commencing design of shore connections.

### 5-5 ELECTRICAL SERVICE.

Ships service, temporary lighting, and ships industrial power are not required for fueling piers and quaywalls. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT regarding electrical systems that directly serve the pier. Evaluate all hazardous requirements and preferences that may be encountered.

### 5-6 TELECOMMUNICATION SYSTEMS.

Fueling piers require telecommunication systems. However, full services that are defined for active and repair berths are not required. Consult with the Activity and the cognizant NAVFAC \4\ FEC /4/ OR USACE DISTRICT for specific requirements. In general, the design guides for active and repair berths are applicable. The systems required are to be evaluated on a project-by-project basis. Lastly, comply with all hazardous requirements associated with fueling piers.

### 5-7 ADDITIONAL REQUIREMENTS.

Refer to \4\ UFC 3-460-01, *Design: Petroleum Fuel Facilities /4/* for additional requirements.

### 5-8 FIRE PROTECTION.

Refer to UFC 3-600-01, *Fire Protection Engineering For Facilities*. Consult with the Fire Protection Engineering Departments, both at the local level and at the NAVFAC /4/ FEC /4/ OR USACE DISTRICT level.

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## CHAPTER 6 MISCELLANEOUS PROVISIONS

### 6-1 FREEZE PROTECTION

#### 6-1.1 Where Required.

Provide freeze protection for saltwater, fresh-water, sanitary-waste (sewage), and oily-waste (bilge) pipes exposed on piers and wharves and in drydocks when located in freezing climates.

#### 6-1.2 Regional Weather Differences.

See Figure D-1 and Table D-1. For design purposes, coastlines within the United States can be divided into the five regions listed below. Table D-1 lists average historical weather data for the five regions. For freeze protection systems at locations outside of the United States, match weather data (insofar as possible) to one of the regions in Table D-1 and design accordingly. The five weather regions are defined as follows:

Region I: "Severe": Alaska, Maine, New Hampshire, Great Lakes and inland locations.

Region II: "Cold": Connecticut, Massachusetts, Rhode Island, and New York.

Region III: "Moderate": Pennsylvania, New Jersey, Delaware, Maryland, and Washington, DC.

Region IV: "Mild": Washington, Oregon, Virginia, and North Carolina.

Region V: "Very Mild": California, South Carolina, Georgia, Texas, Mississippi, Louisiana, Alabama, and Florida.

#### 6-1.3 Methods.

The methods described below vary with climate. Use the methods recommended below when the relative costs of electricity, sewage disposal, and freshwater are not abnormally high. Where the cost of electricity, sewage disposal, or water is abnormally high, then modify the freeze protection system and use an approved method that minimizes operating cost. Use approved life cycle cost procedures and submit analysis.

#### 6-1.4 Protection in Regions I and II

##### 6-1.4.1 Water Lines.

For water lines, provide freeze protection by using a combination of electric heat tape and pipe insulation. The suggested combinations of insulation thickness and heating (watt density) for various pipe sizes are shown in Table D-2. Heat tape should be controlled by remote thermostats having sensors taped to the surface of pipes and under the insulation. Consult with the Activity and the cognizant NAVFAC /4/ FEC /4/ OR USACE DISTRICT regarding preferred heat tape systems and methods. Several

sections of heat tape may be required due to overall pipe length. Provide each section of heat tape with a dedicated thermostat. Thermostats must be in a protected location that is also accessible. The heating requirement given in Table D-2 (6 watts/foot) is the watt density available for a typical electric heat tape. Any watt density from 4 to 10 watts/foot would be suitable, but insulation thicknesses must be adjusted to compensate. Insulation thicknesses given in Table D-2 are based upon polyurethane. Adjust thickness for other insulation materials as based upon their rated thermal conductivity values. Protect backflow devices, valves, and risers with electric heat tape and preformed polyurethane insulation kits. Heat tape systems must be maintainable to be successfully used for the system's expected life span. To improve maintainability, use multiple sections of heat tape instead of extended single circuits. The designer may need to consider special heating systems in which heating elements are placed in channels alongside the pipe. These systems periodically terminate in accessible junction boxes. Maintenance personnel can then easily replace an inoperable section. It is also much easier to troubleshoot when the heating system is divided into reasonable segments with accessible test points.

#### **6-1.4.2 Sewer and Oily Waste Lines.**

A combination of electric heat tape and pipe insulation should be used in accordance with Table D-2 for: (1) exposed gravity sewer piping which drains fixtures directly; (2) exposed oily waste piping; and (3) for those portions of exposed pressure lines (sewage and oily waste) which will not completely drain upon cessation of pumping. Heat tape may not be required (insulation only) for exposed pressure and gravity sewer and oily waste piping (or portions thereof) which receive material intermittently and which drain well when pumping stops. Neither heat tape nor insulation may be required for pipe risers and valves above pier decks and in drydock galleries.

### **6-1.5 Protection in Regions III and IV**

#### **6-1.5.1 Fresh Water Lines.**

For water lines, the preferred method of freeze protection in these regions is to use a combination of insulation and a flushing of water through the pipes. Insulation thickness for various pipe sizes, and pipe sizes for which flushing is necessary, are defined in Appendix D Table D-3. Insulation thicknesses are such that for expected durations of subfreezing temperatures less than 50 percent of pipe contents will freeze. Where flushing is indicated, use thermostatically actuated solenoid valves. Size each valve for a rate at which the entire contents of exposed piping can bleed in 8 to 12 hours. Thermostats should be in protected locations and sensors are to be taped to the surface of pipes and under the insulation. Thermostats should be factory set to open the flushing valves at 30 degrees F (-1.1 degrees C) and to close the valves at approximately 35 degrees F (2 degrees C). Flushing valves (freeze protection valve) and associated thermostats should be located at each ship's connection and at any other line extremity to protect the most remote valve component in the system. Insulation thicknesses given in Table D-3 are based upon polyurethane. Adjust thickness for other insulation materials as based upon their rated thermal conductivity

values. Insulation must also be applied to backflow devices and valves. Special care must be taken to prevent the freezing of flushing valves and associated pipe connections. If water is scarce, or if the winter temperature of buried water mains is below 45 degrees F (7.2 degrees C), heat tape should be used in lieu of flushing. In this event, the design should be based upon the data defined in Table D-4.

#### **6-1.5.2 Sewer and Oily Waste Lines.**

A combination of electric heat tape and pipe insulation should be used in accordance with Table D-4 for: (1) exposed gravity sewer piping which drains fixtures directly; (2) exposed oily waste piping; and (3) those portions of exposed pressure lines (sewage and oily waste) which will not drain completely upon cessation of pumping. Neither insulation nor heating is required for exposed sewer and oily waste piping (or portions thereof) which receive material intermittently and which drain well when pumping stops. This applies to both pressure lines and gravity lines.

#### **6-1.6 Protection in Region V.**

In portions of region V in which the temperature can drop below 25 degrees F (-4 degrees C), use a properly sized flushing valve, atmospheric thermostat, and timer to bleed approximately 35 gallons per inch (132.5 liters per of pipe diameter for each 100 ft (30.5 m) of fresh water pipe. This flushing is to be applied over an 8 to 12 hour period on each day that the ambient temperature drops below 25 degrees F (-4 degrees C). Pipes need not be insulated, but flushing valves and connections must be located at system extremities and must be protected from freezing.

#### **6-1.7 Modification of Requirements for Saltwater.**

Because seawater freezes at a temperature approximately 4.5 degrees F (-15.3 degrees C) lower than that at which freshwater freezes, make the following adjustments when designing freeze protection for exposed saltwater mains:

- In regions I and II, treat saltwater the same as required for freshwater.
- In region III, design as for region IV.
- In region IV, design as for region V.
- In region V, no freeze protection is necessary for saltwater at any location.

#### **6-1.8 Materials**

##### **6-1.8.1 Pipe.**

Piping materials must be metallic where heat tape is required. Where a flushing system is utilized, any approved piping material may be used.

##### **6-1.8.2 Heat Tape.**

Flat style electric heat tape is recommended. Heat tape should be easy to splice and repair and must be waterproof. A low watt density (4 to 10 watts per lineal foot of pipe) is recommended, and the ability to lap the tape without damage should be required. When heat tape is used with the insulation thicknesses listed in Tables D-2 and D-4, they will cycle 30 to 60 percent of the time on the coldest days.

#### **6-1.8.3 Insulation and Covering.**

Closed-cell foam-type insulations (such as cellular glass) having low moisture absorption qualities should be used for Regions I and II due to the destructive effect of freezing on wet insulations. Use closed-cell foam-type insulation for regions III and IV if wave action and/or immersion are possible. Cover all insulation with a watertight metallic or plastic system.

#### **6-1.8.4 Valves and Thermostats.**

Select single-seated solenoid valve shaving flow constants suitable for bleeding proper quantities of water in the prescribed interval. Temperature sensors should be atmospheric or surface type and sense water temperature not ambient air temperature. Thermostats may be bimetallic, thermistor, or resistance (RTD) type, having differentials of 2 degrees F to 5 degrees F (-16.6 degrees C to -15 degrees C)-.

### **6-2 PIPING IDENTIFICATION**

#### **6-2.1 Primary Identification.**

Identify each valve on a pier, wharf, or drydock by a plain language brass tag, and labeled. (Example: "potable water" or "sewer".) Additionally, at each shore-to-ship utility connection, name plates or stenciled letters near the connection must identify the utility in plain language.

#### **6-2.2 Color Coding.**

Two sources of design requirements govern color-coding for pier, wharf, and drydock piping.

##### **6-2.2.1 Distribution Piping On or Under Deck and Ashore.**

Such piping, exclusive of shore-to-ship utility connections, must be color coded in accordance with MIL-STD-101, *Color Code for Pipelines and for Compressed Gas Cylinders*. Applicable requirements must be specified in the design documents.

##### **6-2.2.2 Shore-to-Ship Utility Connections.**

Such piping (including valves, operating levers, ends of hose assemblies, risers, and adjacent piping) must be specified to be color-coded in accordance with Table 6-1. Color-coding may also extend to adjacent curbs, protective rails, posts, and walls.

### **6-3 OPERATIONAL NOTICES.**

Provide the following operational notices. Consult with the Activity and the cognizant NAVFAC /4/ FEC /4/ OR USACE DISTRICT regarding other desired notices, nameplates, warning signs, and so forth.

- Bleed systems must be marked with the following warning:

”Freeze protection valve.  
Water will flow below 35 degrees F.  
Do not close.”

- Heat tape systems must be marked with the following warning:

“Heat tape system (self limiting).  
Do not disconnect power.”

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**Table 6-1 Color Code for Shore-to-Ship Utility Connections<sup>1,4</sup>**

<u>SHORE SERVICE<sup>2</sup></u>	<u>COLOR</u>	<u>REFERENCE NUMBER<sup>3</sup></u>
Potable Water (40-81 psi)	Blue, Dark	15044
Nonpotable Water for Fire/Flushing/Cooling (100-175 psi)	Red	11105
Chilled Water	Striped Blue/White	11044/17886
Oily Waste Discharge	Striped Yellow/Black	13538/17038
Sewer	Gold	17043
Steam and condensate (150 psig)	White	17886
Compressed Air (100-125 psi)	Tan	10324
High Pressure Air (3000 psi)	Striped Yellow/Gray	13538/16081
Fuel	Yellow	13538

**NOTES FOR TABLE 6-1**

1. If additional information is needed on color-coding systems, contact NAVFAC \4\4/ or USACE.
2. Pressures shown are nominal pressures and represent average conditions.
3. The reference numbers refer to Federal Standard 595B, *Colors Used in Government Procurement*.
4. Also, see "General Specifications for Ships of the U.S. Navy", COMNAVSEASYSKOM, 1991.

## CHAPTER 7 U.S. ARMY REQUIREMENTS

### 7-1 APPLICABILITY

This chapter is applicable for waterfront facilities designed for U.S. Army vessels.

### 7-2 POTABLE WATER

Provide potable water in sufficient capacity to permit the filling of a vessel's tank in such time as to avoid delays in the operation of the vessel.

#### 7-2.1 Quantity and Pressure Requirement.

Provide a minimum flow of 100 gpm (6.3 l/s) with a minimum residual pressure of 25 psi (173 kPa) at the most remote outlet.

#### 7-2.2 Piping and Outlets.

Install one 2-1/2 in (63.5 mm) connection at each service outlet. Potable water outlets on piers and wharves should have a reduced pressure-type backflow prevention device. The piping must be insulated and provided with electrical heat tape if the lines are normally full of water and subject to freezing temperatures. Where thermal expansion is a problem, provision should be made for expansion joints or loops. Figure 7-1 shows a typical potable water connection in the pier deck.

### 7-3 ELECTRIC POWER

#### 7-3.1 Electrical System Characteristics.

The main electrical system providing power to ships will be nominal 480-volts, three-phase, 60-Hz, supplied from substations preferably located on the piers. For lighting service, a 120-volt, 60-cycle, single-phase power may be provided.

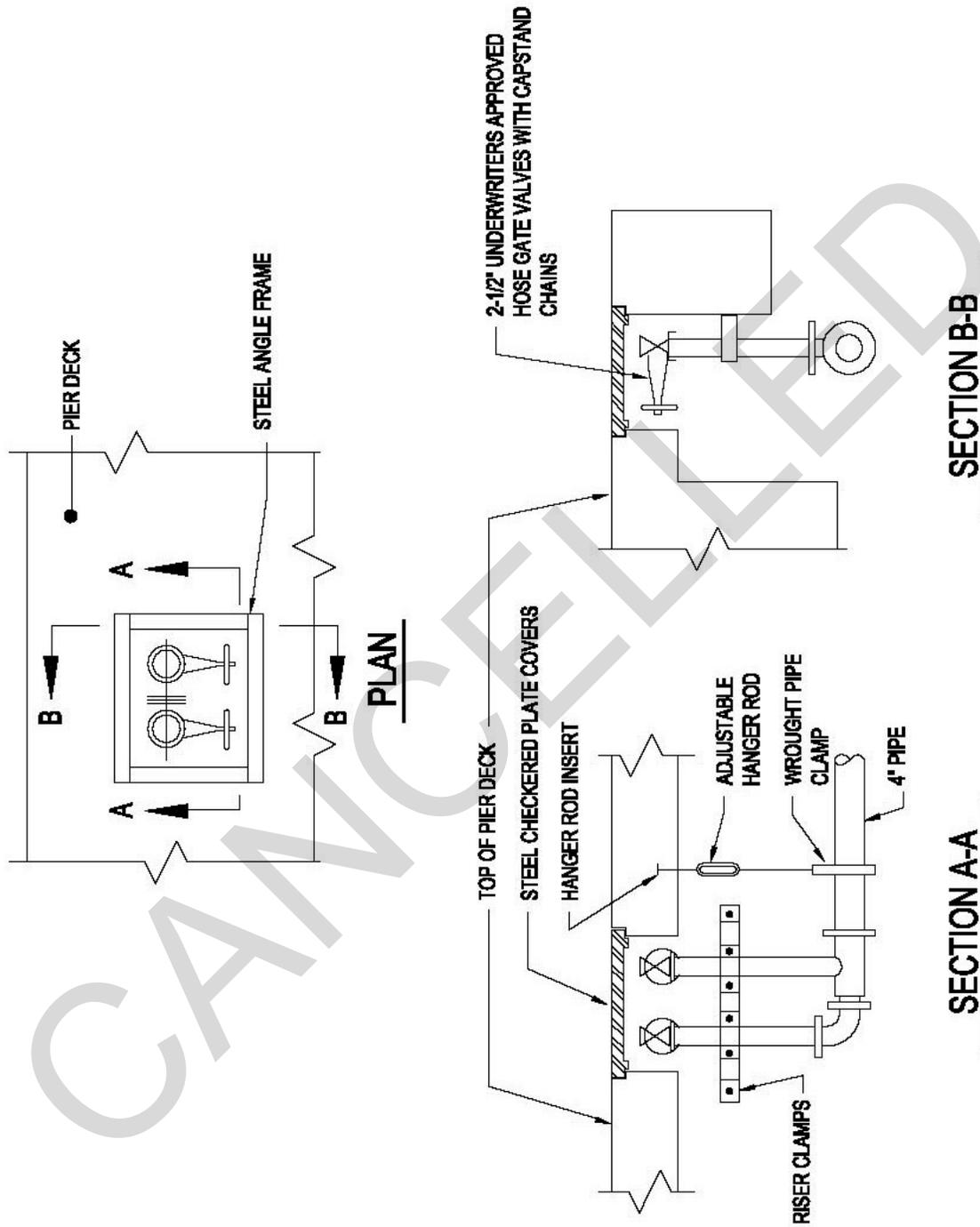
#### 7-3.2 Ground System.

At piers, wharves, and other waterfront structures, a ground system that will measure not more than 3 ohms must be provided for permanent electrical equipment.

### 7-4 LOCATION AND NUMBERS OF SERVICE POINTS.

A minimum of two service points will be provided for each berth and located for the convenience of the using vessels. Each service point must supply electric power and water service as outlined above. Depending upon the physical site conditions of each specific installation, the point of connection for each service may be located in a single service box, or may be placed in separate but closely grouped boxes. Boxes should be located as close as practicable to the berthing face of the structure so that connected hoses and electric cables are not subject to vehicular traffic damage.

Figure 7-1 Typical Water Supply Connection for an Army Pier



## 7-5 MISCELLANEOUS

### 7-5.1 Telephone Service.

Provide telephone service and outlet connectors for each berth. Locate for the convenience of the using vessels.

### 7-5.2 Lighting.

Satisfactory illumination should be ensured for night operations. For open watering areas on the pier where ship loading or unloading occurs, a lighting intensity of at least 5 footcandles (54 lux) should be maintained. The illumination level of 5 footcandles (54 lux) should also be provided for areas of warehouses or storage buildings.

### 7-5.3 Fire Protection.

Refer to UFC 3-600-01, *Fire Protection Engineering For Facilities*.

### 7-5.4 Sanitary Facilities and Sewage Disposal.

A dockside connection to a sewage disposal system must be provided for the disposal of sewage and oily wastes from vessels.

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**APPENDIX A**

**REFERENCES**

**GOVERNMENT PUBLICATIONS**

1. Unified Facilities Criteria

<http://dod.wbdg.org>

UFC 3-190-06  
Protective Coatings and Paints

UFC 3-220-10N  
Soil Mechanics

UFC 3-230-19N  
Water Supply Systems

UFC 3-400-02 Design:  
Design: Engineering Weather  
Data

UFC 3-430-09  
Exterior Mechanical Utility  
Distribution

UFC 3-460-01  
Design: Petroleum Fuel  
Facilities

UFC 3-501-01  
Electrical Engineering

UFC 3-560-01  
Electrical Safety O&M

UFC 3-570-02N,  
Electrical Engineering  
Cathodic Protection

UFC 3-600-01  
Fire Protection Engineering for  
Facilities

UFC 4-152-01  
Design: Piers & Wharves

UFC 4-213-10

Design: Graving Drydocks

UFC 4-832-01N

Design: Industrial and Oily  
Wastewater Control

2. Unified Facilities Guide Specifications

<http://dod.wbdg.org/>

UFGS 26 05 33

Dockside Power Connection  
Stations

UFGS 26 11 16

Secondary Unit Substations

UFGS 26 13 00.00 20

SF6 Insulated Pad-Mounted  
Switchgear

UFGS 26 23 00.00 40

Switchboards and Switchgear

UFGS 26 42 13.00 20

Cathodic Protection by  
Galvanic Anodes

UFGS 26 42 15.00 10

Cathodic Protection System  
(Steel Water Tanks)

UFGS 26 42 17.00 10

Cathodic Protection System  
(Impressed Current)

UFGS 33 30 00

Sanitary Sewers

3. DoD Single Stock Point for Military Specifications,  
Standards and Related Publications

<http://dodssp.daps.dla.mil/>

CID A-A-59326

Coupling Halves, Quick-  
Disconnect, Cam-Locking  
Type

FED-STD-595B

Colors Used in Government  
Procurement

MIL-C-24368/1

Connector Assemblies, Plug,  
Power Transfer, Shore-to-Ship  
and Ship-to-Ship, 500 Volts,  
500 Amperes, 60 Hertz,  
Symbol Number 1160

MIL-C-24368/4

Connector Assemblies, Plugs  
and Receptacles, Electric,  
Power Transfer, Shore to Ship  
and Ship to Ship, 500 Volts,  
500 Amperes, 60 Hertz,  
Symbol Numbers 1162.1,  
1162.2, 1162.3

MIL-C-24368/5

Connector Assemblies, Plug,  
Submarine Shore Power  
Transfer, Shore to Ship and  
Ship to Ship, 500 Volts, 400  
Amperes, 60 Hertz, Three-  
Phase, Symbol Number 1149

MIL-C-52404

Connection Hose, Fire and  
Water

\4\ MIL-DTL-915 /4/

Cable, Electrical, for Shipboard  
Use, General Specification

\4\ MIL-DTL-24643 /4/

Cables, Electric, Low Smoke  
Halogen-Free, for Shipboard  
Use, General Specification

MIL-S-12165

Strainer Suction, Fire House,  
and Strainer Suction, Hose

MIL-STD-101

Color Code for Pipelines and  
for Compressed Gas Cylinders

4. NAVFAC ATLANTIC  
6506 Hampton Blvd  
Norfolk, VA 23508-1278

<https://portal.navfac.navy.mil/portal/page/portal/navfac/>

5. Naval Facilities Engineering Service Center  
(NFESC)

1100 23<sup>rd</sup> Avenue  
Port Hueneme, CA 93043-4370

[www.nfesc.navy.mil](http://www.nfesc.navy.mil)

6. Code of Federal Regulations

<http://www.access.gpo.gov/nara/cfr/>

MIL-STD-1399  
Interface Standard for  
Shipboard Systems

MIL-HDBK-1004/6  
Lightning Protection  
P-442  
Economic Analysis Handbook

MO-201  
Electric Power Distribution  
Systems

MO-340  
Ship-to-Shore Hose Handling  
Operations Manual

TDS-2025-SHR  
Polymer Composite Utility Pipe  
Hangers

TN-1586  
Steam Separator Test and  
Evaluation

Bilge and Oily Wastewater  
Treatment System

29 CFR 1910, Occupational  
Safety and Health  
Administration, Department of  
Labor:

Occupational Safety and  
Health Standards

40 CFR 141, U.S.  
Environmental Protection  
Agency:

National Primary  
Drinking Water  
Regulations  
National Secondary  
Drinking Water  
Regulations

40 CFR 1700, U.S.  
Environmental Protection  
Agency, Department of  
Defense:

Uniform National  
Discharge Standards for  
Vessels of the Armed  
Forces

7. Naval Sea Systems Command  
(NAVSEASYSCOM)  
1333 Isaac Hull Avenue, SE  
Washington Navy Yard, DC 20376-1080  
[www.navsea.navy.mil](http://www.navsea.navy.mil)

S9086-AB-ROM-010  
Naval Ship's Technical Manual  
(NSTM)

S9593-BF-DDT-010  
Oil Pollution Abatement  
System

362-2333  
Air Circuit Breakers (Fused),  
Navy Type AQB-FL400

8. Naval Ship Weapons Systems Engineering Station  
Commanding Officer  
Naval Ship Weapons Systems Engineering Station,  
Code 5700  
Port Hueneme, CA 93043

59300-AW-EDG-010/EPISM  
Electrical Plant Installation  
Standards Methods  
(EPISM)

9. Submarine Maintenance Engineering, Planning  
and Procurement Activity (SUBMEPP)  
P.O. Box 2500  
Portsmouth Naval Shipyard  
Portsmouth, NH 03804-2500  
[www.submepp.navy.mil](http://www.submepp.navy.mil)

Maintenance Standard (MS)  
Number 3240-081-089  
Inspect and Repair Shore  
Power Cables

**NON-GOVERNMENT PUBLICATIONS**

1. American National Standards Institute (ANSI)  
1819 L Street, NW, 6th Floor  
Washington, DC 20036  
(202) 293-8020  
Fax: (202) 293-9287  
<http://www.ansi.org/>

ANSI /NEMA C57.12.29  
Pad-Mounted Equipment—  
Enclosure Integrity for Coastal  
Environments

ANSI/NEMA C84.1  
Electric Power Systems and  
Equipment—Voltage Ratings (60  
Hertz)

2. American Society of Heating, Refrigerating and Air  
Conditioning Engineers, Inc (ASHRAE)  
1791 Tullie Circle N.E.  
Atlanta, GA 30329-2305  
(800) 527-4723  
(404) 636-8400  
Fax: (404) 321-5478  
[www.ashrae.org](http://www.ashrae.org)

ASHRAE  
Handbook, Fundamentals

3. ASTM International  
100 Barr Harbor Drive  
West Conshohocken, PA 19428-2959  
(610) 832-9585  
Fax: (610) 832-9555  
[www.astm.org](http://www.astm.org)

Metals and Alloys in the Unified  
Numbering System

ASTM A 276  
Standard Specification for Stainless  
Steel Bars and Shapes

ASTM B 148  
Standard Specification for Aluminum-  
Bronze Sand Castings

ASTM B 164  
Standard Specification for Nickel-  
Copper Alloy Rod, Bar and Wire

ASTM B165  
Standard Specification for Nickel-  
Copper Alloy (UNS N04400) Seamless  
Pipe and Tube

ASTM D2240  
Standard Test Method for Rubber  
Property—Durometer Hardness

4. Compressed Gas Association (CGA)

4221 Walney Road, 5th Floor  
Chantilly VA 20151-2923  
(703) 788-2700  
Fax: (703) 961-1831  
Email: [cga@cganet.com](mailto:cga@cganet.com)  
[www.cganet.com](http://www.cganet.com)

CGA G-7.1  
Commodity Specification for Air

5. Insulated Cable Engineers Association (ICEA)  
Box 1568  
Carrollton, GA 30112  
[www.icea.net](http://www.icea.net)

ICEA S-66-524  
Cross-Linked-Thermosetting  
Polyethylene Insulated Wire and  
Cables(Also known as NEMA WC7)

ICEA S-75-381  
Portable Power Feeder Cables (Also  
known as NEMA WC 58)

ICEA T-27-581  
Standard Test Methods for Extruded  
Dielectric Cables (Also known as  
NEMA WC 53)

6. Institute of Electrical and Electronics Engineers  
(IEEE)  
3 Park Avenue, 17<sup>th</sup> Floor  
New York, NY 10016-5997  
[www.ieee.org](http://www.ieee.org)

IEEE-48  
Standard Test Procedures and  
Requirements for Alternating Current  
Cable Terminations 2.5kV through  
765kV

7. InterNational Electrical Testing Association (NETA)  
P.O. Box 687  
Morrison, CO 80465  
[www.netaworld.org](http://www.netaworld.org)

Maintenance Testing Specifications for  
Electrical Power Distribution Equipment  
and Systems

8. International Organization for Standardization (ISO)  
1, rue de Varembe'  
Case Postale 56  
CH-1211 Geneva 20, Switzerland  
[www.iso.org](http://www.iso.org)

ISO 4649  
Rubber, Vulcanized or Thermoplastic –  
Determination of Abrasion Resistance  
Using Rotating Cylindrical Drum Device

9. NACE International  
1440 S. Creek Drive,  
Houston, TX 77048-4906  
(281) 228-2600  
Fax: (281) 228-6300

NACE RP0169  
Control of External Corrosion of  
Underground or Submerged Metallic  
Piping Systems

<http://nace.org/nace/index.asp>

10. National Electrical Manufacturers Association (NEMA)  
1300 North 17<sup>th</sup> Street, Suite 1752  
Rosslyn, VA 22209  
(703) 841-3200  
Fax: (703) 841-5900  
<http://www.nema.org/>

11. National Fire Protection Association (NFPA)  
1 Batterymarch Park  
P.O. Box 9101  
Quincy, MA 02269-9101  
(617) 770-3000  
Fax: (617) 770-0700  
[www.nfpa.org](http://www.nfpa.org)

12. Society for Protective Coatings (SSPC)  
40 24<sup>th</sup> Street, 6 Floor  
Pittsburgh, PA 15222-4656  
(877) 281-7772  
[www.sspc.org](http://www.sspc.org)

13. Underwriters Laboratories, Inc (UL)  
333 Pfingsten Road  
Northbrook, IL 60062-2096  
[www.ul.com](http://www.ul.com)

14. Water Environment Federation (WEF)  
601 Wythe Street,

NACE RP0285  
Standard Recommended Practice –  
Corrosion Control of Underground  
Storage Tank Systems by Cathodic  
Protection

ANSI/NEMA C57.12.29  
Pad-Mounted Equipment – Enclosure  
Integrity for Coastal Environments

ANSI/NEMA C84.1  
Electric Power Systems and Equipment  
-- Voltage Ratings (60 Hertz)

NFPA 20  
Standard for the Installation of  
Stationary Pumps for Fire Protection

NFPA 70  
National Electrical Code

NFPA 780  
Standard for the Installation of  
Lightning Protection Systems

Painting Manual, Volume 2  
Systems and Specifications (Includes  
color identification index system)

UL 44  
UL Standard for Safety Thermoset-  
Insulated Wires and Cables

UL 486A-486B  
UL standard for Wire Connectors

UL 94  
UL Standard for Safety of Flammability  
of Plastic Materials for Parts in Devices  
and Appliances Testing

MOP FD-5  
Gravity Sanitary Sewer Design and

**UFC 4-150-02**

12 May 2003

With Change 4, 7 March 2011

Alexandria VA, 22314-1994

(800) 666-0206

Fax: (703) 684-2492

[www.wef.org](http://www.wef.org)

Construction

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## APPENDIX B

### GLOSSARY

Active Berthing. A pier or wharf with berths used for homeport or light repair purposes, usually with a full or partial crew aboard, and always with ships in active status.

Activity. The organization (or organizations) that is responsible for the daily and routine operation and maintenance of the associated waterfront facility.

APTS. Activity providing telephone service. The organization responsible for the daily and routine operation and maintenance of the waterfront's telecommunication system (or systems).

Berth. A specific, marked-off length, along a pier or wharf, containing ships services appropriate for the ship classes which may be assigned to it.

Berthing Pier. A general term for a pier with berths and ships services.

Berthing Plan. A plan devised by each facility showing all berthing areas with ships assignments. May be permanent or temporary, depending upon the type of facility.

Bollard. A single-post fitting to which mooring lines from vessels are attached.

Capstan. A motorized, vertical-drum device used to tension lines for positioning ships, usually in drydock.

Cleat. A mooring fitting having two diverging horizontal arms to which mooring lines from vessels are attached.

Cold Iron. Used to describe the condition of a ship when all shipboard boilers, engines, and generators are inoperative during repairs and can furnish none of the required ships services.

Cooling/Flushing Water. Water (usually nonpotable or salt) supplied to ships for condenser-cooling, fixture-flushing and other miscellaneous uses.

Dedicated Berth. A berth having required services for, and dedicated to use by, a specific ship for an extended period of time.

NAVFAC EFD/EFA. Engineering field division/engineering field activity. The geographical representative of the Naval Facilities Engineering Command (NAVFAC) responsible for the implementation of Navy policies, guidance and instructions.

Graving Drydock. A permanent concrete drydocking structure requiring the use of caisson and dewatering pumps.

Hotel Services. Dockside utilities provided for a ship at berth (also called ships services, utility services, and cold iron services).

Inactive Berthing. Permanent or semi-permanent berthing areas for ships out of service, with crew normally not aboard.

Nested Ships. Two or more ships berthed side by side, with utility services supplied from berth side to the outer ships via ships header systems or hoses and cables strung across decks.

Oily Waste. Water (usually salt) from ships bilge which has been contaminated with petroleum products (fuel or lube oils) and which cannot discharge either to surface waters or to sanitary sewer.

Overhaul Facility. Generally used interchangeably with Repair Facility.

Pier. A dock, built from the shore out into the harbor, which is used for berthing and mooring vessels.

POL. Petroleum, oil and lubricants. An acronym used to describe petroleum products, and the facilities used in their storage and handling. As used herein, applies to marine fuels, jet fuels and lubricants.

Quaywall. A heavy gravity or platform structure fronting on navigable water, behind which earth fill is placed to a level grade along its length.

Repair Facility. Locations where ship repair activities take place, such as at a shipyard or ship-repair facility. Facilities may utilize repair piers, drydocks, or both. (Also, Overhaul Facility.)

Telecommunications. Systems of communicating speech or impulses via wire or cable over distances, such as telephone, data transmission, coded transmission, cable TV and signal or alarm circuits.

USACE DISTRICT. The geographical representative of the U.S. Army Corps of Engineers (USACE) responsible for the implementation of Army policies, guidance and instructions.

Wharf. A dock, oriented approximately parallel to shore, with more than one access connection with the shore; a wharf is used for berthing or mooring vessels. May also be as above, except with continuous connection to shore.

**APPENDIX C**

**SHIP UTILITY REQUIREMENTS**

- Table C-1 Shore Services - Steam
- Table C-2 Shore Services - Compressed Air
- Table C-3 Shore Services - Salt or Non Potable Water - Overhaul and Drydock
- Table C-4 Shore Services - Potable Water
- Table C-5 Shore Services - Oily Waste/Waste Oil (OWWO) Discharge
- Table C-6 Shore Services - Sanitary (CHT) Discharge
- Table C-7 Shore Services - Electrical
- Table C-8 Shore Services -Telecommunications

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**Table C-1 Shore Services – Steam** <sup>1 2 3</sup>

Ship Symbol	(a) Intermittent Heating Loads <sup>4</sup> (lb/hr) for Outdoor Temperatures of:				(b) Constant Load <sup>5</sup> (lb/hr)	Overhaul (lb/hr)	Ships Connection Data <sup>6</sup>			
	10 <sup>0</sup> F	30 <sup>0</sup> F	50 <sup>0</sup> F	70 <sup>0</sup> F			L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>										
CVN-65	42,000				7,000		481S	29	1	4" Gate
							716S	29	1	3-2" Angle
							403P	29	1	3-2" Angle
							806P	29	1	3-2" Angle
CVN-68	45,000				5,000		528S	23	1	4-2" Angle Stop V.
							698S	23	1	6-2" Angle Stop V.
							493P	23	1	4-2" Angle Stop V.
CVN-78 <sup>7</sup>										
<b>SURFACE COMBATANT</b>										
CG-47 <sup>8</sup>	11,200	11,200	11,200	8,745	3,270		328S	25	1	2" Male Steam Boss
							335P	25	1	2" Male Steam Boss
DDG-51 <sup>7</sup>										
DDG-79 <sup>7</sup>										
DDG-1000 <sup>7</sup>										
FFG-7 <sup>7</sup>										
LCS-1 <sup>7</sup>										
LCS-2 <sup>7</sup>										
<b>SUBMARINE</b>										
SSN-688						3000	210			6" 600# Weld Neck
SSN-21 <sup>9</sup>										
SSN-774						50,000	246S			5" NPS, Class 600
SSBN-726 & SSGN <sup>10</sup>										
<b>AMPHIBIOUS</b>										
LCC-19,20	7,000	5,500	4,700	4,100	3,000		304S	26	3	
							304P	26	3	
LHA-1	11,500	7,500	3,800	1,600	2,500		375S	46	2	2" Male Steam Boss
							375P	46	2	2" Male Steam Boss
LHA-6 <sup>7</sup>										
LHD-1	8,000	6,000	4,000	4,000	2,500		375S	46	2	2" Male Steam Boss
							375P	46	2	2" Male Steam Boss
LHD-8 <sup>7</sup>										
LPD-4	6,000	3,700	2,200	1,300	2,200		328S	34	4	
							326P	34	4	
LPD-17 <sup>7</sup>										
LSD-41 <sup>11,12</sup>					7,400		220S	22	2	
							220P	22	2	
LSD-49 <sup>12</sup>					7,400		220S	35	2	
							220P	35	2	
<b>AUXILIARY</b>										
AKE-1 <sup>7</sup>										
AOE-6							515S	28		
							545P	28		
ARS-50										
AS-39	6000	6000	6000	6000	6000		636S	58	2	

NOTES TO TABLE C-1

1. Loads based on ship's peacetime complement (no air wing or troops).
2. Maximum single ship demand at shore connections is column (a) plus column (b).
3. For multiple ships, see Steam Service Diversity Factors
4. Steam quantity required to achieve normal environmental temperature in ship spaces relative to the outdoor temperatures shown. Interpolation between temperature columns is permissible.
5. Galley, laundry, hot water, etc.
6. L is the distance (in feet) of the connection aft of the point of stem of the ship H is the height (in feet) of the connection above the design waterline.  
  
Designations "P" and "S" refer to port side and starboard side, respectively.  
  
Where more than one connection exists, all locations are shown.  
  
The designation "N" refers to the number of shipboard hose connections at the given locations.
7. Steam not required.
8. Loads based on absolute, worst case condition. Upon completion of ShipAlt CG47-00588K (All Electric), there will no longer be a requirement for steam.
9. Information contained in NAVSEA Dwg 6726570 Rev C (NOFORN) .
10. Information contained in NAVSEA Dwg 4639983 Rev E (NOFORN) .
11. Figure based on normal supply to ship when berthed at NNSY.
12. Steam used for hot water and ship services not significantly affected by outside temperatures. Mid-Life electrical upgrades will remove steam from these ships.

**Table C-2 Shore Services - Compressed Air <sup>1</sup>**

Ship Symbol	Quantity <sup>2</sup> (SCFM)	Pressure <sup>3</sup> (PSIG)	Minimum Branch Size <sup>4</sup> (IN)	Minimum Outlet Risers Per Berth	Ships Connection Data <sup>5</sup>			
					L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>								
CVN-65	2,400	125	4	5	455S	31	1	2"
					899S	31	1	2"
CVN-68 <sup>6</sup>	2,400	125	4	5				
CVN-78 <sup>7</sup>								
<b>SURFACE COMBATANT</b>								
CG-47	1,000	125	3	4				
DDG-51	1,000	125	3	3	144S	21	1	2 1/2"
					274P	21	1	2 1/2"
DDG-1000 <sup>8</sup>								
FFG-7	1,000	125	3	3	360S	28	1	1 1/2"
LCS-1 <sup>7</sup>								
LCS-2 <sup>7</sup>								
<b>SUBMARINE</b>								
SSN-688 <sup>9</sup>	750	125	2	2				
SSN-21 <sup>9</sup>	750	125						
SSN-774 <sup>9</sup>								
SSBN-726 & SSGN <sup>10</sup>								
<b>AMPHIBIOUS</b>								
LCC-19	1,050	125	2.5	4	369S	46		
					369P	46		
LCC-20	300	125	2.5	4	369S	46		
					369P	46		
LHA-1 <sup>6</sup>	800	125						
LHA-6 <sup>8</sup>								
LHD-1 <sup>6</sup>	800	125						
LHD-8 <sup>8</sup>								
LPD-4 <sup>11</sup>	1,000	125						
LPD-17 <sup>9</sup>								
LSD-41	300	125	3	4	220C	35		
LSD-49	300	125	3	4	220C	35		
<b>AUXILIARY</b>								
AKE-1	207	125						
AOE-6					470S	28		
					475P	28		
ARS-50	500	125	2	2				
AS-39								

NOTES TO TABLE C-2

1. Low pressure compressed air requirements shown.
2. For multiple ships, use diversity factor.
3. Minimum required at connections. Higher pressures may be necessary where specifically directed by NAVFAC or the using agency.
4. This is size of pipe from main to (and including) outlet riser.
5. L and H refer to the location of ships connections. L is the distance (in feet) of the connection aft of the point of stem of the ship and H is the height (in feet) of the connection above the design waterline.

Designations P and S and C refer to port, starboard and center respectively. Where more than one connection exists, all locations are shown.

The designation "N" refers to the number of shipboard connections at the given locations

6. No shore connection; normal procedure is for ship's force to identify valve in system to be pulled and temporary hoses are attached where valve was pulled .
7. Portable only.
8. Compressed air not required.
9. Not required at normal pier tie up .
10. Information contained in NAVSEA Dwg 4639983 Rev E (NOFORN).
11. No designated shore air connections on board.

**Table C-3 Shore Services - Salt or Non Potable Water - Overhaul and Drydock Berthing**

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Ship Symbol	Total Demand (gpm)	Fire-Fighting Flow (gpm)	Cooling/Flushing Flow (gpm)	Ships Connection Data <sup>1</sup>			
				L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>							
CVN-65	10,000	3,000	7,000	478S	29	4	4" GATE FL W/ 2 1/2" HOSE ADAPT
				724S	29	4	4" GATE FL W/ HOSE ADAPT
				414P	29	4	4" GATE FL W/ HOSE ADAPT
				731P	29	4	4" GATE FL W/ HOSE ADAPT
CVN-68	10,000	3,000	7,000	546S	25	4	3 1/2" GATE 250 PSIG
				777S	34	4	3 1/2" GATE 250 PSIG
				530P	25	4	3 1/2" GATE 250 PSIG
				785P	25	4	3 1/2" GATE 250 PSIG
CVN-78	10,000	3,000	7,000	601S	25	4	4" HOSES
				617S	25	4	4" HOSES
				817S	25	4	4" HOSES
				529P	25	4	4" HOSES
				781P	25	4	4" HOSES
<b>SURFACE COMBATANT</b>							
CG-47	1,250	1000	250	158P	24	4	2 1/2"
				360S	24	4	
DDG-51	1,250	1000	250	148S	21	4	2 1/2"
				278S	21	4	2 1/2"
				150P	21	4	2 1/2"
				348P	21	4	2 1/2"
DDG-1000							2 1/2"
FFG-7	1,250	1000	250	282S	28	4	2 1/2"
LCS-1 <sup>2</sup>							
LCS-2 <sup>2</sup>							
<b>SUBMARINE</b>							
SSN-688 <sup>3</sup>				275 P/S			
SSN-21 <sup>4</sup>				144/235			TWO 2.5-7.5 NH HOSE CONN MALE
SSN-774	1180	230	950	150/250			2 1/2"
SSBN-726 & SSGN <sup>5,6</sup>			110				2 1/2"
<b>AMPHIBIOUS</b>							
LCC-19,20	1,250	1000	250				
LHA-1 <sup>7</sup>	3,125	2,500	625				
LHA-6	8,000			273S	55	4	4" FIRE HOSE
				644S	55	4	4" FIRE HOSE
				238P	54	4	4" FIRE HOSE
				707P	55	4	4" FIRE HOSE
LHD-1				266S	55	4	4" FIRE HOSE
				644S	55	4	4" FIRE HOSE
				210P	55	4	4" FIRE HOSE

				700P	55	4	4" FIRE HOSE
LHD-8	8,000			252S	54	4	4" FIRE HOSE
				252P	54	4	4" FIRE HOSE
LPD-4	1,875	1,500	375				
LPD-17							
LSD-41	2500	2,000	500				
LSD-49	2500	2,000	500				
<b>AUXILIARY</b>							
AKE-1							
AOE-6	1,875	1500	375	180S	28		
				608S	28		
				179P	28		
				575P	28		
ARS-50	625	500	125				
AS-39	1875	1500	375				

**NOTES TO TABLE C-3**

1. L is the distance (in feet) of the connection aft of the stem of the ship.  
H is the height (in feet) of the connection above the design waterline.  
Designations "P" and "S" refer to port side and starboard side respectively.  
Where more than one connection exists, all locations are shown.
2. Salt or Non Potable Water not required.
3. Provide 2000 gpm @ 40psi; also provide 600 gpm @ 40 psi from separate, but simultaneous source as emergency backup.  
Drydock provides (F10) steel bolted fire hose connection (male) for standard fire hose.  
Drydock also provides connection for 12" ASW hull valves.
4. Provide 600 gpm @ 65psi for cooling (inboard connection in engine room) and 336 gpm @ 100psi for flushing and firefighting.  
Inboard connections fore and aft.
5. For cooling/flushing; only flushing value is provided.
6. Information contained in NAVSEA Dwg 4639983 Rev E (NOFORN).
7. Planning Yard (NNSY) advises no shore connections; use 15 hose connections to ships fire plugs.

/4/

**Table C-4 Shore Services - Potable Water**

Ship Symbol	Normal Requirement with Ships Compliment (GPD)	Requirement with Air Wing or Troops Aboard (GPD)	Ships Connection Data <sup>1</sup>			
			L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>						
CVN-65	100,000	140,000	460S	28	1	2 1/2" GLOBE
			640S	28	1	2 1/2" GLOBE
			640P	28	1	2 1/2" GLOBE
			840P	28	1	2 1/2" GLOBE
CVN-68	100,000	185,000	300S	29	1	2 1/2" GLOBE
			540S	29	1	2 1/2" GLOBE
			300P	29	1	2 1/2" GLOBE
			540P	29	1	2 1/2" GLOBE
CVN-78 <sup>2</sup>		235,000	417S	25	2	2.5" HOSE CONN
			673S	25	2	2.5" HOSE CONN
			501P	25	2	2.5" HOSE CONN
			777P	25	2	2.5" HOSE CONN
<b>SURFACE COMBATANT</b>						
CG-47	16,000		242S	21	1	2.5" HOSE CONN
			242P	21	1	2.5" HOSE CONN
DDG-51	9500		254S	22	1	2.5" HOSE CONN
			254P	22	1	2.5" HOSE CONN
DDG-1000						2.5" HOSE CONN
FFG-7	10800		325S	32	1	2.5" HOSE CONN
			325P	32	1	2.5" HOSE CONN
LCS-1	4500				1	2.5" HOSE CONN
LCS-2	4500				1	2.5" HOSE CONN
<b>SUBMARINE</b>						
SSN-688 <sup>3</sup>	5000		150 (2.5' OFF CL - P)		1	
SSN-21	5000		138.3 (16.3' OFF CL -P)		1	1.5 NPS HOSE CONN
SSN-774	5000		150 C		1	1.5"
SSBN-726 &SSGN	5000		312.9		1	2.5" HOSE CONN
<b>AMPHIBIOUS</b>						
LCC-19,20	33,000	55,000	281S	44		
			313P	44		
LHA-1	28,000	85,000	337 S	46	1	2.5" HOSE CONN
LHA-6 <sup>4</sup>			427S	63	1	2.5" HOSE CONN
			553S	34	1	2.5" HOSE CONN
			371P	15	1	2.5" HOSE CONN
LHD-1	32,000	90,000	680 S	45	1	2.5" HOSE CONN
LHD-8 <sup>4</sup>			427S	63	1	2.5" HOSE CONN
			553S	34	1	2.5" HOSE CONN
			371P	15	1	2.5" HOSE CONN

LPD-4	15,000	48,300	327S	35		
			356P	35		
LPD-17	15,000	40,000	200S	24	1	2 1/2"
			200P	24	1	2 1/2"
LSD-41	14,000	25,000	260S	36		
			208P	36		
LSD-49	12,000	25,000	260S	37		
			216P	37		
<b>AUXILIARY</b>						
AKE-1	92,000		220S	78S	1	2 1/2"
			225P	65P	1	2 1/2"
AOE-6	21,000		321S	68		
			433S	68		
			321PS	68		
			449P	68		
ARS-50	3000					
AS-39			FAN TAIL	MAIN DECK	1	2.5" HOSE CONN

**NOTES TO TABLE C-4**

1. L is the distance (in feet) of the connection aft of the stem of the ship.  
  
H is the height (in feet) of the connection above the design waterline.  
  
Designations "P" and "S" refer to port side and starboard side respectively.  
  
Where more than one connection exists, all locations are shown.
2. Reduce requirement by 35% if airwing is not embarked.
3. Connection is PW-8; 1 1/2" NPS globe valve w/hose connection; silver-bronze union end (MIL-F-1183) w/adaptor for Hose 'B' thread size; 1 1/2" male x 1 1/2 fem.
4. Quantity = 200 gpm @ 87 psi.

**Table C-5 Shore Services - Oily Waste/Waste Oil (OWWO) Discharge**

Ship Symbol	Pump Station	Pump	Pump Rating, GPM	Q <sub>PEAK</sub> , GPD	Q <sub>AVE</sub> , GPD	Ship Connection Data <sup>1</sup>			
						L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>									
CVN-65	1	1A	200	35,000	35,000	605S	29	3	2.5"
		1B	200			616P	29	3	2.5"
CVN-68 to 71	1	1A	90	80,000	35,000	680S	23	1	2.5"
						512P	23	1	2.5"
CVN-72 to 77	1	1A	90	80,000	35,000	680S	23	2	2.5"
		1B	90			512P	23	1	2.5"
CVN-78 <sup>2</sup>							25	1	2.5"
<b>SURFACE COMBATANT</b>									
CG-47	1	1A	50	12,000	3000	384S (Oily Waste Transfer Pump, 50 gpm)	24	1	2.5"
		1B	15			386P (Oily Waste Transfer Pump, 50 gpm)	24	1	2.5"
	2	2A	50			386S (Gas Turbine Drain Pump, 15 gpm)	24	1	2.5"
		2B	15			380P (Gas Turbine Drain Pump, 15 gpm)	24	1	2.5"
DDG-51	1	1A	50	12,000	3000	253S	21	1	2.5"
	2	2A	50			253P	21	1	2.5"
DDG-1000								1	2.5"
FFG-7	1	1A	50	6750	1500	244S	28	1	2"
						244P	28	1	2"
LCS-1			90~180		500			1	2.5"
LCS-2			90~180		500			1	2.5"
<b>SUBMARINE</b>									
SSN-688	1	1A	230	500	250	215		1	2.5"
SSN-21	1	1A	280	500	250	202.5(14' OFF CL-S)		1	
		1B	280			205.2'(4' OFF CL-S)		1	
SSN-774	1	1A	230			159.56 (15.4' OFF CL-P)		1	1.5"
						218.47' (8.87' OFF CL-S)		1	1.5"
SSBN-726 &SSGN	1	1A	230	500	250	152'11" (12'10" OFF CL -P)		1	2.5"
						376'10" (45" OFF CL - P)		1	2.5"
<b>AMPHIBIOUS</b>									
LCC-19,20	1	1A	100	21,000	6400				
LHA-1	1 (FWD)	1A	18	21,000	6400	448S	45		2.5"
		1B	18			448P	45		2.5"
		1C	18						
		1D	18						
	2	2A	54						
LHA-6						553S (Oily Waste)	34	1	2.5"
						553S (Synthetic Oil)	34	1	2.5"
						455P (Oily Waste)	24	1	2.5"
						455P (Synthetic Oil)	24	1	2.5"
LHD-1	1 (FWD)	1A	54	21,000	6400	539S	45		2.5"
		1B	54			441P	55		2.5"
		1C	54						
LHD-8 <sup>3</sup>						553S (Oily Waste)	34	1	2.5"
						553S (Synthetic Oil)	34	1	2.5"
						455P (Oily Waste)	24	1	2.5"
						455P (Synthetic Oil)	24	1	2.5"

LPD-4	1	1A	18	21,000	6400				
	2	2A	90						
LPD-17	1	1A	54	21,000	6400	463S 312P	13	1	2.5"
		1B	54				24	1	2.5"
	2	2A	10						
	3	3A	10						
LSD-41				4800	2700				
LSD-49				4800	2700				
<b>AUXILIARY</b>									
AKE-1	1	1A	35			407S	45	1	2"
AOE-6	1	1A	15			515S	30	1	2.5"
	2	2A	50			526P	30	1	2.5"
	3	3A	50			516S	30	1	1.25"
	4	4A	15			528P	30	1	1.25"
ARS-50				500	275				
AS-39				15,000	10,000				

**NOTES TO TABLE C-5**

1. L is the distance (in feet) of the connection aft of the stem of the ship.  
  
H is the height (in feet) of the connection above the design waterline.  
  
Designations "P" and "S" refer to port side and starboard side respectively.  
  
Where more than one connection exists, all locations are shown.
2. Oily Water 8000 gpd (45,000 gal); Waste Oil 40,000 gal/offload; Aircraft Waste Fuel 9400 gal/offload. All use same deck connection.  
  
Ship OWWO system has two 90 gpm pumps and is capable of discharging 90-180 gpm. Shipboard standard operating procedure while pierside is to operate with only one pump and discharge at the lower rate of 90 gpm.
3. Oily waste requirement to be determined; Synthetic oily waste = 54 gpm.

**Table C-6 Shore Services - Sanitary (CHT) Discharge**

Ship Symbol	Pump Station	Pump	Pump Rating	Ships Connection Data <sup>1</sup>			
				L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>							
CVN-65	1	1A	400 GPM	320P	27		4"
		1B	400 GPM	348S	45		4"
	2	2A	400 GPM	428P	27		4"
		2B	400 GPM	452S	27		4"
	3	3A	400 GPM	688S	27		4"
		3B	400 GPM	828P	27		4"
	4	4A	400 GPM				
		4B	400 GPM				
	5	5A	400 GPM				
		5B	400 GPM				
	6	6A	400 GPM				
		6B	400 GPM				
7	7A	400 GPM					
	7B	400 GPM					
CVN-68 to 71	1	1A	400 GPM	485P	23		4"
		1B	400 GPM	536S	23		4"
	2	2A	400 GPM	740P	23		4"
		2B	400 GPM	759S	23		4"
	3	3A	400 GPM				
3B		400 GPM					
CVN-72 to 77	1	1A	400 GPM	485P	23		4"
		1B	400 GPM	309S	23		4"
	2	2A	400 GPM	759P	23		4"
		2B	400 GPM	802S	23		4"
CVN-78 <sup>2</sup>			250 GPM	FWD STB	25	1	4"
			500 GPM	AFT STB	25	2	4"
<b>SURFACE COMBATANT</b>							
CG-47	1	1A	100 GPM	200S	34	1	4"
		1B	100 GPM	362S	34	1	4"
	2	2A	100 GPM	190P	34	1	4"
		2B	100 GPM	362P	34	1	4"
	3	3A	100 GPM				
3B		100 GPM					
DDG-51	1	1A	40 GPM	146S	21	1	4"
		1B	40 GPM	329S	21	1	4"
	2	2A	40 GPM	149P	21	1	4"
		2B	40 GPM	331P	21	1	4"
DDG-1000					1	4"	
FFG-7	1	1A	100 GPM	204S	28	1	4"
		1B	100 GPM	204P	28	1	4"
LCS-1			250 GPM			1	4"
LCS-2			250 GPM			1	4"
<b>SUBMARINE</b>							
SSN-688	1	1	25 GPM	77 (11' OFF CL - P)		1	2.5"
SSN-21	1	1	25 GPM	132 (3' OFF CL - P)			2.5"
SSN-774	1	1	100 GPM	173 (12' OFF CL - P)			2.5"

SSBN-726 & SSGN	1	1	25 GPM	153'5" (9'9" OFF CL - P)		1	2.5"
				292'5" (12'6" OFF CL - P)		1	2.5"
<b>PATROL</b>							
PC-1	1	1	60GPM	FR 30.5 (3' FWD OF MIDSHIPS; 9' OFF CL - S)	MAIN DECK	1	2.5"
					10' ABV WL		
<b>MINE WARFARE</b>							
MCM-1	1	1	25GPM	FR 32 (14'6" OFF CL - S)	01 LVL	1	1.5"
				FR 32 (14'6" OFF CL - P)	01 LVL	1	1.5"
<b>AMPHIBIOUS</b>							
LCC-19,20	1	1A	150 GPM	S		1	
		1B	150 GPM	S		1	
	2	2A	150 GPM	P		1	
		2B	150 GPM	P		1	
LHA-1	1	1A	400 GPM	231S	45	1	4"
		1B	400 GPM	231P	45	1	4"
	2	2A	300 GPM	448S	45	1	4"
		2B	300 GPM	448P	45	1	4"
LHA-6			400 GPM	294S	34		4"
				434S	24		4"
				301P	24		4"
				455P	24		4"
LHD-1	1	1A	300 GPM	280S	55	1	4"
		1B	300 GPM	287P	55	1	4"
	2	2A	300 GPM	420S	55	1	4"
		2B	300 GPM	441P	55	1	4"
LHD-8			400 GPM	294S	24		4"
				434S	24		4"
				301P	24		4"
				455P	24		4"
LPD-4	1	1A	150 GPM	2P/2S		1	
		1B	150 GPM			1	
	2	2A	150 GPM			1	
		2B	150 GPM			1	
	3	3A	150 GPM				
		3B	150 GPM				
LPD-17	1	1A	120 GPM	200S	24	1	4"
		1B	120 GPM	463S	24	1	4"
	2	2A	120 GPM	200P	24	1	4"
		2B	120 GPM	312P	13	1	4"
	3	3A	200 GPM				
		3B	200GPM				
	4	4A	200 GPM				
		4B	200GPM				
LSD-41	1	1A	100 GPM	P		1	
		1B	100 GPM	S		1	
	2	2A	100 GPM				
		2B	100 GPM				

LSD-49	1	1A	100 GPM	P		1	
		1B	100 GPM	S		1	
	2	2A	100 GPM				
		2B	100 GPM				
<b>AUXILIARY</b>							
AKE-1	1	1A	50 GPM	407S	45	1	3"
	2	2A	17 GPM	414P	31	1	3"
		2B	17 GPM				
	3	3A	310 GPM				
		3B	310 GPM				
AOE-6 <sup>3</sup>	1	1A	100 GPM	265S	33	1	
		1B	100 GPM	430S	33	1	
	2	2A	100 GPM	265P	33	1	
		2B	100 GPM	440P	33	1	
ARS-50	1	1A	100 GPM	S		1	
		1B	100 GPM	P		1	
AS-39	1	1A	100 GPM	S		1	
		1B	100 GPM	P		1	
	2	2A	100 GPM	STERN		1	
		2B	100 GPM				
	3	3A	100 GPM				
		3B	100 GPM				
	4	4A	100 GPM				
		4B	100 GPM				
	5	5A	100 GPM				
		5B	100 GPM				
ATF-166							
<b>USCG</b>							
WPB-1301			550 GPD	P	MAIN DECK	1	4"

**NOTES TO TABLE C-6**

1. L is the distance (in feet) of the connection aft of the stem of the ship.  
 H is the height (in feet) of the connection above the design waterline.  
 Designations "P" and "S" refer to port side and starboard side respectively.  
 Where more than one connection exists, all locations are shown.
2. CVN 78 utilizes a Type II MSD biological treatment system. As wastewater comes into the ship's processing tank (50,000 gal fwd and 100,000 gal aft), clean effluent spills over into a wet well (500 gal fwd and 2100 gal aft), discharge pumps come on and empty tanks at ratings indicated. Note processing tanks are only emptied when there is maintenance required for the tank.
3. CHT fwd and aft systems are independent and must both be hooked up for shore discharge of sewage.

**Table C-7 Shore Services – Electrical**

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Ship Symbol	Ampacity Per Station <sup>2</sup>	Required Ampacity of Shore Power Service <sup>3</sup>	Ships Connection Data <sup>1</sup>			
			L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>						
CVN-65 <sup>4</sup>	3200	8600	440 P	30	1	
	3200		460 S	30	1	
	3200		520 S	30	1	
	3200		640 S	30	1	
	3200		664 P	30	1	
	3200		704 S	30	1	
CVN-68, 69	1440 <sup>5</sup>	2800	548 S	30	1 - 4	
	1440 <sup>5</sup>		704 S	30	1 - 4	
	4000	16000	300 S	30	1	
	4000		312 S	30	1	
	4000		1000 S	40	1	
	4000		1016 S	40	1	
CVN-70 to 77 <sup>6</sup>	1440 <sup>5</sup>	2800	548 S	30	1 - 4	
	1440 <sup>5</sup>		704 S	30	1 - 4	
	4000	16000	296 S	30	2	
	4000		1016 S	40	2	
CVN-78 <sup>7</sup>	1359	1307/1569	460S	25	4	
	1359		704S	25	4	
<b>SURFACE COMBATANTS</b>						
CG-46 to 51 <sup>8</sup>	1200	5200	316S	44	1 - 13	
	4000		316P	44	1 - 13	
CG-52 and up <sup>8</sup>		4000	316S	44	1 - 10	
	4000		316P	44	1 - 10	
DDG-51	4800	4500	265C	25	1 - 12	
DDG-1000 <sup>5</sup>		470	260S	10	1 - 2	
			260P	10	1 - 2	
FFG-7	2800	2800	252C	35	1 - 7	
JHSV-1	800	800	320P	28	1 - 2	
	800	800	320S	28	1 - 2	
LCS-1	1600	1600	213C	40	1 - 4	
LCS-2	1600	1600	152S	35	1 - 4	

Ship Symbol	Ampacity Per Station <sup>2</sup>	Required Ampacity of Shore Power Service <sup>3</sup>	Ships Connection Data <sup>1</sup>			
			L	H	N	SIZE
<b>SUBMARINE</b> <sup>8</sup>						
SSN-688	1600	1600 <sup>9</sup>	146 C		1 - 4	
	1600		210 C		1 - 4	
SSN-21	1600	1600 <sup>9</sup>	52 C		1 - 4	
	1600		73 C		1 - 4	
SSN-774 <sup>10</sup>	400	2400	144 C		1 - 1	
	1200		222S		1 - 3	
	800		222P		1 - 2	
SSBN-726 & SSGN	1600	1600 <sup>9</sup>	137 C		1 - 4	
	1600		406 C		1 - 4	
<b>PATROL</b>						
PC-1CL	200	170	107 P	11	1	
<b>AMPHIBIOUS</b>						
LCC-19,20			442 P/S	28	2	
LHA-1	4000	7200	445S	37	1 - 10	
	4000		445P	37	1 - 10	
	3200		791P	57	1 - 8	
LHA-6	1600	1903	441P	24	2 - 2	
	1600		434S	24	2 - 2	
	800		812C	53	1 - 2	
LHD-1	4000	7200	420 P	25	1 - 10	
	4000		440 S	25	1 - 10	
	3200		800 C	48	1 - 8	
LHD-8	1600	2400	420 P	25	2 - 2	
	1600		440 S	25	2 - 2	
	800		800 C	48	1 - 2	
LPD-4	1600	1400	240 C	50	1 - 4	
LPD-17	8000	8000	88C	48	1 - 20	
LSD-41 <sup>11</sup>	2400	2400	252C	34	1 - 6	
LSD-49 <sup>11</sup>	3200	2160	252 P	34	1 - 8	
<b>MINE WARFARE</b>						
MCM-1						
MHC-51	800	576	104 P	29.5	1	
<b>AUXILIARY</b>						
AKE-1 <sup>12</sup>	4000	8000	310C	55	1 - 10	
			333C	55	1 - 10	
AOE-6	4000	3200	435S	55	1 - 10	
	4000		435P	55	1 - 10	
ARS-50	800		92 P	30	1	
AS-39 <sup>13</sup>	4000	A 4200 B 8000	370S	38	1 - 1	
	4000		370P	38	1 - 1	
	4000		370S	48	1 - 1	
	4000		370P	48	1 - 1	
	8000		610S	28	1 - 2	

NOTES TO TABLE C-7

1. L is the distance (in feet) of the connection aft of the stem of the ship.  
  
H is the height (in feet) of the connection above the design waterline.  
  
Designations "P" and "S" refer to port side and starboard side respectively.  
  
Where more than one connection exists, all locations are shown.  
  
P/S Two station locations, one port and one starboard, at an equal distance from the bow, of which only one may be used at a time to receive power, one half of the total number of stations given are on port side, one half are on starboard C is centerline station location ST is stern station location; if power is delivered to the stern station, the port and starboard stations would normally not be used for receiving power.  
  
N = number of service points - number of cables per service point.
2. Capacity is given in amperes. Unless otherwise indicated, power to load center is 450V, three phase, three-wire, 60 Hz, ungrounded. Power factor is approximately 0.8. The number of receptacles per station may be obtained by dividing per station capacity by 400.
3. Required ampacity of shore power service is the maximum power that the ship will demand from the shore power system. The shore power service transformer shall be sized to provide the "Required ampacity of shore power service" for the ship moored at the respective berth. Note that the shore power service transformer is not necessarily sized to provide the ampacity equivalent to the product of the required number of shore power circuits and the rating (400A) of the shore power circuits.
4. CVN-65: The port station is only used when the ship is in drydock. Power is 480V.
5. Power is 4160V, three phase, three wire, 60 Hz, ungrounded.
6. CVN 70 and higher will not require any 480 volts electrical services.
7. Power to load center is 13,800V, three phase, three wire, 60 Hz, ungrounded; 1307/1569 correspond to 25MW load (without air wing) and 30MW load (with air wing). For additional information regarding the shore-to-ship interface, refer to NAVSEA Drawing 802-7094558, CVN Class Aircraft Carrier Electrical Interface Characteristics (NOFORN).
8. CG-47 through CG-51: A total of 13 shore power receptacles are provided at each of these two (port and starboard) stations. Three receptacles (1200A) are used for a feed-through circuit to a tended ship and 10 receptacles (4000A) are used for the ships shore power station. CG-52 and following have no feed-through circuits.
9. Normal hotel service load is 1600 amps.  
  
Special testing of submarines, usually conducted at shipyards, requires an increased level of shore power (super shore power). Depending upon local operating policies, either additional circuits from the same service(s) are connected in conjunction with the normal "hotel" circuits to provide a combined increased level of shore power or additional circuits from completely separate service(s) are provided in addition to the normal "hotel" service. Note that for both modes of operation, the additional circuits are connected directly to the ship's switchboard bus.

10. It is required that the shunt interlock circuits for the three SSN774 Class services be independent of each other and the interlock should insure that all of the breakers for a given service (e.g. port) trip open at the same time in the event of an over current condition.

11. Between FY08 & FY14 LSD Class goes through a Mid Service Life Electrical Upgrade.

LSD 41-48 goes from 6 cables (2400A) to 10 cables (4000A).

LSD 49-52 goes from 8 cables (3200A) to 12 cables (4800A).

12. T-AKE 1 requires that shore power be delivered at 505V-515V.

T-AKE 1 uses its own DC system to detect grounds, whereas shoreside facility uses an AC system to detect grounds. Prior to arrival at berth, shoreside facility must disable its ground detection system for that particular berth and rely upon the T-AKE 1 ground detection system.

13. A = Requirement shown represents the demand of the tender while not tending.

B - Requirement shown represents the demand of the tender while tending; this includes the requirements of the tender plus the maximum requirements of the ships being tended.

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**Table C-8 Shore Services -Telecommunications**

Ship Symbol	Telephone Lines (Pairs)		Ships Connection Data <sup>1</sup>			
	Active Lines <sup>2</sup>	Cable Size at Berth <sup>3</sup>	L	H	N	SIZE
<b>AIRCRAFT CARRIERS</b>						
CVN-65	60	200	612S	32	1	
			612S	03 LVL	1	
CVN-68	60	200	303S	26	1	
			1008S	35	1	
CVN-78 <sup>4</sup>	60 Min/100 Max		613S	25		
			545P	25		
<b>SURFACE COMBATANT</b>						
CG-47	15	50	287			
DDG-51	15	50	274S	21		
			274P	21		
DDG-1000 <sup>5</sup>	20 to 40 lines					
FFG-7	8	50				
LCS-1 <sup>6</sup>	10					
LCS-2 <sup>6</sup>	10					
<b>SUBMARINE</b>						
SSN-688	5	25	98			
SSN-21	8		80			
SSN-774	10		95.69' (0.67' OFF CL - P)			
SSBN-726 &SSGN	10	25	136'10"			
<b>AMPHIBIOUS</b>						
LCC-19	150	180	208P			
			208P			
LCC-20	20	100	208P			
			208P			
LHA-1	120		80S			
			80P			
LHA-6 <sup>7</sup>	80		434S	24		
			812S	54		
			441P	24		
LHD-1	120		78S			
			78P			
LHD-8 <sup>7</sup>	80		434S	24		
			812S	54		
			441P	24		
LPD-4	10	15	270C			
LPD-17			463S			
			463P			
LSD-41	10	50	250S			
			250P			
LSD-49	20	30	250S			
			250P			
<b>AUXILIARY</b>						
AKE-1						
AOE-6	10	50	205 C			
ARS-50						
AS-39						

NOTES TO TABLE C-8

1. L is the distance (in feet) of the connection aft of the stem of the ship.  
  
H is the height (in feet) of the connection above the design waterline.  
  
Designations "P" and "S" refer to port side and starboard side respectively.  
  
Where more than one connection exists, all locations are shown.
2. Total number of active lines required for any ship is sum of column for "active lines" for the ship class and the embarked staff requirements necessary where specifically directed by NAVFAC or the using agency.
3. Column "cable size at berth" lists the size of cable to be provided at berths designated for various ship types. Cable sizes given in column "cable size at berth" include the ship requirement, the appropriate embarked staff requirement, and an allowance for spare pairs.
4. Also requires Internet T-1, T-100, ISDN SIPRNET/NIPRENET 2 lines.
5. Also requires fiber optic LAN connectivity.
6. Also requires (1) Internet T-1, T-100, ISDN Digital T-1/ISDN - 1 line; (2) SIPRNET/NIPRENET BL II 1 connection.
7. Also requires 2 fiber optic connections for IT21/ISNS and BFTT.
8. Embarked staff requirements.  
Fleet Commander - 20  
CARGRU Commander - 8  
CREWDESGRU COMMANDER - 12  
DESRON COMMANDER - 10  
PHIBGRU COMMANDER - 12  
PHILBRON COMMANDER - 15  
MAB STAFF - 12  
SERVGRU COMMANDER - 8  
SUBRON COMMANDER - 15  
PHMRON COMMANDER - 12

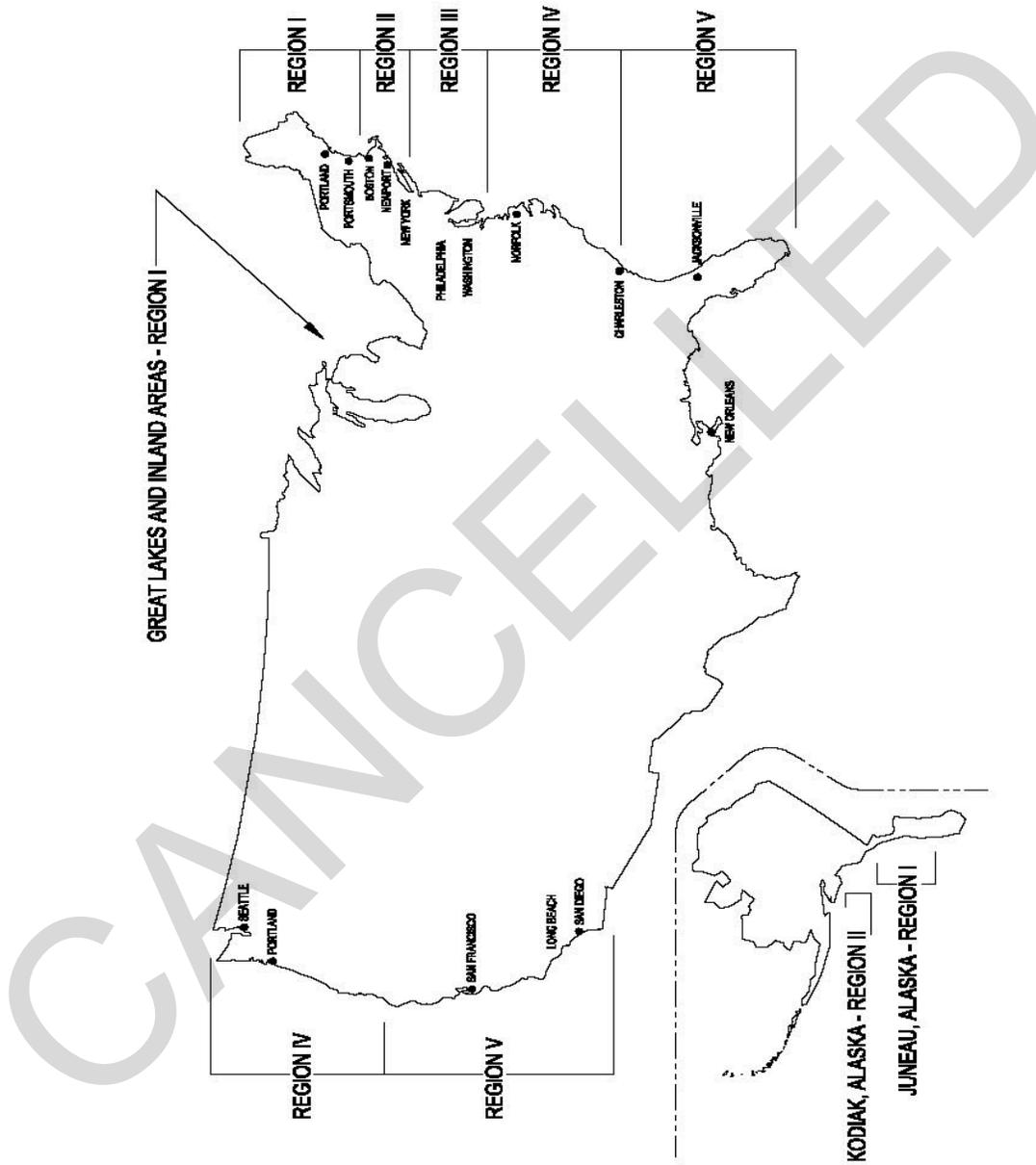
**APPENDIX D**

**CLIMATOLOGICAL DATA**

- Figure D-1 U.S. Winter Weather Severity by Region
- Table D-1 Regional Weather Data
- Table D-2 Freeze Protection by Insulation and Heating: Suggested Combinations for Regions I and II
- Table D-3 Freeze Protection by Insulation and Flushing: Suggested Combinations for Regions III and IV
- Table D-4 Freeze Protection by Insulation and Heating: Suggested Combinations for Regions III and IV

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Figure D-1 U.S. Winter Weather Severity by Region



**Table D-1 Regional Weather Data**

AVERAGE	EXTREME	MEDIAN	AVERAGE OF 97 1/2%			
<u>JANUARY</u>	<u>MINIMUM</u>	<u>ANNUAL</u>	<u>97 1/2%</u>	<u>TEMP AND EXTREME</u>		
	Temp	Temp	EXTREMES	Temp	MINIMUM	
<u>REGION</u>	<u>(deg F)</u>	<u>(deg F)</u>	<u>(deg F)</u>	<u>(deg F)</u>	<u>(deg F)</u>	<u>DAYS</u>
I	24	-30	-11	0	-15	1275
II	29	-14	1	10	-2	1125
III	34.5	1	7	15	8	950
IV	34.5	3	16	24	13	750
V	50.5	17	21	32	24	450

**Table D-2 Freeze Protection by Insulation and Heating: Suggested Combinations for Regions I and II**

PIPE SIZE (inch)	REGION I		REGION II	
	INSULATION THICKNESS (inch)	HEATING (watts/foot)	INSULATION THICKNESS (inch)	HEATING (watts/foot)
2	1/2	6	1/2	6
3	1/2	6	1/2	6
4	1	6	1	6
6	1	6	1	6
8	1-1/2	6	1-1/2	6
10	1-1/2	6	1-1/2	6
12	1-1/2	6	1-1/2	6

**Table D-3 Freeze Protection by Insulation and Flushing: Suggested Combinations for Regions III and IV**

PIPE SIZE (inch)	REGION III		REGION IV	
	INSULATION THICKNESS (inch)	FLUSHING FEATURE	INSULATION THICKNESS (inch)	FLUSHING FEATURE
2	1	Yes	1	Yes
3	1	Yes	1	Yes
4	1	Yes	1	Yes
6	1	Yes	1	Yes
8	1	No	1	No
10	1	No	1	No
12	1	No	1	No

**Table D-4 Freeze Protection by Insulation and Heating: Suggested Combinations for Regions III and IV**

PIPE SIZE (inch)	REGION III		REGION IV	
	INSULATION THICKNESS (inch)	HEATING (watts/foot)	INSULATION THICKNESS (inch)	HEATING (watts/foot)
2	1/2	6	1/2	6
3	1/2	6	1/2	6
4	1/2	6	1/2	6
6	1/2	6	1/2	None
8	1	None	1	None
10	1	None	1	None
12	1	None	1	None

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## APPENDIX E OPERATION AND MAINTENANCE CRITERIA FOR SHORE-TO-SHIP POWER

### E-1 Critical Components.

All electrical components whose failure could affect the reliability of the electrical distribution system supplying power to ships are identified as critical components of the shore to ship power system and are placed under the maintenance program defined in this enclosure. Critical components are the shore power circuit breaker, the permanently installed cables between the shore power circuit breaker and the power connection station (turtleback), the power connection station receptacles, and the portable power cable assemblies used for supplying shore power services to ships. Each portable power cable assembly is defined to consist of two electrical connectors and the cable in between.

#### E-1.1 Critical Component Inventory Records.

A history record will be established and maintained covering each shore to ship power system critical component. The record will document via inspection checklists all work completed and by whom. Cable and connections shall be tagged in accordance with the Shore Power Cable Assembly Nomenclature Detail, as shown in Figure E-4 and entered into Single Platform MAXIMO and other appropriate maintenance planning databases.

- **One-line diagram:** One-line diagrams, illustrating the equipment ratings and system configuration from the utility point of service, are prepared and kept current by the activities in accordance with NAVFAC Manual MO-201, *Electric Power Distribution Systems*. Plot plans will be annotated to show the location of all shore to ship power system components.
- **Power System Study:** An activity power system study, including load flow, fault current analysis, coordination of protective devices, and arc flash is prepared in accordance with MO-201, *Electric Power Distribution Systems*.

### E-2 Paralleling Transformers.

If a ship is supplied by two or more shore transformers, the ship's force will be directed, through standard ship operating procedures, not to parallel the transformers through the ship's bus unless the senior ship's electrician verifies correct phase orientation between power sources, and the supplying activity authorizes the parallel operation. If shore transformers are paralleled through the ship's bus, short circuit currents may be increased to unsafe levels and circulating currents may overheat and destroy cables, transformers, and switchgear on board ship or on shore.

### **E-2.1 Paralleling Shipboard Generation with the Shore Power System.**

Paralleling of ship's service generators with the shore power system is prohibited except for the shortest time necessary to transfer load to or from shore power.

### **E-3 Cables for Shore-to-Ship Service.**

Shore-to-ship cables are normally provided by the Activity. For 480 volts, three-phase, three-wire service, cables should be ungrounded, standardized lengths of single cable with three conductors, Type THOF-500, conforming to military spec \4\ MIL-DTL-915, *Cable, Electrical, for Shipboard Use /4/*, and should be used for loads not exceeding 400 amps. For 4,160 volts, three-phase service to nuclear aircraft carriers, cables should be SHD350GC 8 kV, non-shielded insulated, PVC-jacketed cable, in accordance with Insulated Cable Engineers Association (ICEA) S-66-524, *Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cables*.

#### **E-3.1 Low Voltage Cables.**

- Existing portable cables used for 480 volt shore to ship power service may be \4\ MIL-DTL-915 /4/ type THOF-500 or type SHOF-500 in accordance with \4\ MIL-DTL-915 /4/. Low smoke cable specified by \4\ MIL-DTL-24643 /4/ which is for use on ships, shall not be used for shore-to-ship power applications. Its softer jacket is susceptible to damage.
- New portable cables used for 480 volt shore to ship power service shall be three conductor type "Enhanced THOF-500" or "Enhanced Plus THOF-500" as shown in Figures E-1, E-2, E-3. Equivalent or better cables from other sources may be considered as approved by Navy technical authority.

#### **E-3.2 Medium Voltage Cables.**

The portable cables used for 4160 volt and 13800 volt shore to ship power service shall be three conductor, 350 kcmil type SHD-GC with Chlorinated Polyethylene (CPE) jacket. Insulation and jacket shall conform to ICEA S-75-381. Cables for 4160 volt service shall be 8 kV or 15 kV. Cables for 13800 volt service shall be 15 kV. However, cable sizes larger than 350 kcmil may be used with approval by Navy technical authority.

#### **E-3.3 Standard Cable Lengths.**

Activities will maintain an inventory of portable shore to ship electric power cables in lengths required for the ships. Lengths will be selected and constructed

to minimize the requirements for in-line connections. All cable runs will be of equal length to minimize unequal load sharing.

**E-3.4 Cable Storage.**

Cables not in use should be stored appropriately. Covered off pier storage locations are highly desirable.

**E-4 Shore Power Circuit Breakers**

**E-4.1 Low Voltage Cable Overcurrent Protection for Submarines.**

The long-time pickup settings of the 450 volt shore to ship power service circuit breakers for submarines shall be adjusted so that they match nominal ratings of equipment on the submarine. (Currently, the limiting ratings for equipment on the submarine is 435 amperes. If the 435 ampere setting is not a standard setting on the existing equipment, then the next higher setting is acceptable. The available "next higher setting" choice is 480A). Circuit breaker settings in excess of 435A shall be documented and submitted to NAVFAC with sufficient technical justification of the setting. Shore activities shall provide written notification to the submarines prior to connection focusing on the load requirements and load monitoring, breaker settings, and safety impacts. The instantaneous pickup setting shall be coordinated with the available short circuit amperes and associated system devices.

**E-4.2 Low Voltage Cable Overcurrent Protection for Surface Ships.**

The long-time pickup settings of the 450 volt shore to ship power service circuit breakers for surface ships shall be adjusted to 430 amperes. If the 430 ampere setting is not a standard setting on the existing equipment, then the next higher setting is acceptable. The available "next higher setting" choice is 480A. Circuit breaker settings in excess of 430A shall be documented and submitted to NAVFAC with sufficient technical justification of the setting. The instantaneous pickup setting shall be coordinated with the available short circuit amperes and associated system devices.

**E-4.3 Medium Voltage Cable Overcurrent Protection.**

The long-time pickup setting of the shore to ship power service circuit breakers shall be adjusted to 400 amperes. If the 400 ampere setting is not a standard setting on the existing equipment, then the next higher setting is acceptable. The cable overcurrent protection will be based on the lowest rated service system device which is usually the fixed cables (normally 350kcmil 105C conductors rated 440A in conduit in air) between the substations and the receptacles for the portable cables, therefore the service rating could be as high as 440A. Metal-clad switchgear with vacuum power circuit breakers will be equipped with programmable microprocessor relays which will allow the over current pickup to be set precisely to the desired setting. Circuit breaker settings in excess of 400A shall be documented and submitted to NAVFAC with sufficient technical

justification of the setting. The instantaneous pickup setting shall be coordinated with the available short circuit amperes and associated system devices.

#### **E-5 Cable Connectors**

Connectors. Cable connectors are available in two types: (1) one single, multiple conductor type (1-3/c cable); and (2) single conductor type grouped in a cluster of three (3-1/c cables). A typical three-conductor outlet assembly is illustrated in Figure F-4. Figure F-5 illustrates the single-conductor type connector.

- Low Voltage Terminations
  - All low voltage portable power cables will be terminated with a MIL-C-24368/1 (procured from vendors on the Qualified Products List (QPL)) plug at the ship end of the cable for surface ships.
  - All low voltage portable power cables will be terminated with a MIL-C-24368/5 (procured from vendors on the QPL) plug at the ship end of the cable for submarines.
  - The termination device at the service end of the cable must be compatible with the design of the dockside power connection station (turtleback) and may be terminated with one of the following:
    - a MIL-C-24368/1 plug, for existing installations
    - a single pole connector which meets the environmental and test requirements of the MIL-C-24368 and the additional requirements identified is shown in Figure F-5
    - a UL 486A listed plug.
    - an equivalent or better connector as approved by Navy technical authority.
  - Install terminations in accordance with manufacturer's recommendations.
- Low Voltage In-line Connections. In-line single pole connectors and lug to lug connections shall meet the same requirements as identified above. Male and female cable mount in-line connectors may be used to connect shorter cable segments together to make longer cable circuits as necessary.

- **Medium Voltage Terminations.** All medium voltage portable power cables will be terminated at the ship end of the cable with a heat shrinkable termination (Institute of Electrical and Electronics Engineers standard IEEE-48 class 1) specifically designed for SHD-GC cables. The termination device at the service end of the cable must be compatible with the design of the dockside power connection station (turtleback) and may be terminated the same as the ship end of the cable or with a coupler plug that is compatible with the receptacle at the dockside power connection station. The termination devices shall be assembled on to the cable per the manufacturer's instructions. Terminate the SHD-GC cable ground and check conductors within the cable breakout boot or to the appropriate termination pin integral with the coupler plug.

## **E-6 Maintenance of Portable Power Cable Assemblies**

### **E-6.1 Tests and Inspections for Submarine Portable Power Cable Assemblies.**

Electrical tests and inspections shall be in accordance with Maintenance Standard (MS) Number 3420-08 1-089. These tests and inspections shall be conducted annually. Results of the contact tightness checks, conducted in accordance with paragraph 1.g of Maintenance Standard (MS) Number 3420-081-089, shall be included on the written notification provided to ships forces prior to each shore power service connection to the submarine, identified in paragraph E-4.1 above.

### **E-6.2 Tests and Inspections for Surface Ship Portable Power Cable Assemblies.**

Electrical tests and inspections shall be in accordance with International Electrical Testing Association Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems (NETA MTS) (most recent edition) for cables and the manufacturer's instructions for connectors. Over potential tests are not required, but may be performed on the cable assemblies that fail insulation-resistance tests as a means to locate cable faults and to verify cable integrity. These tests and inspections shall be conducted annually.

### **E-6.3 Cable Repair.**

Cables with damage other than to the outer jacket shall be removed from service permanently. Repair jackets using a heat shrinkable wrap around mining cable repair sleeve, cold repair elastomeric strips for mining cables, or a similar product. Repair of the coupler plugs and receptacles shall be performed in accordance with the manufacturers' instructions of these cable repair products or shall be in accordance with reference (b) MS NO.3420-08 1-089.

### **E-6.4 Connector Repairs.**

Repairs to MIL-C-24368/5 connectors shall be in accordance with reference (b) MS NO. 3420-08 1-089 Repairs to MIL-C-24368/1 and MIL-C-24368/4 connectors, and medium voltage coupler plugs shall be in accordance with manufacturer's instructions.

**E-6.5 Splicing**

Splicing of portable shore to ship power cables is not recommended for 480V shore power cables. Medium voltage portable power cables shall not be spliced under any conditions.

**E-7 Maintenance of Shore to Ship Power Permanent Components**

**E-7.1 Electrical Tests and Inspections.**

Electrical tests and inspections for the shore power circuit breakers and associated protective relay and the permanently installed cables between the shore power circuit breaker and the power connection station (turtleback) shall be performed in accordance with NETA MTS. Electrical tests and inspections for the power connection station receptacles shall be in accordance with the manufacturer's instructions. Over potential tests are not required, but may be performed on the cable assemblies that fail insulation-resistance tests as a means to locate cable faults and to verify cable integrity. Note that complete visual inspection of inaccessible components is not required. Inspection interval (visual and mechanical tests) shall be annual. Maintenance interval shall be every two years. These intervals may be reduced, as required, based upon equipment condition or operating environment.

**E-7.2 Repair**

Repair of permanent components shall be performed in accordance with the manufacturer's instructions.

**E-7.3 Breaker Operation**

Whenever shore power circuit breakers operate on instantaneous trip, do not re-energize associated shore power circuits until the cause of the fault has been cleared and the circuit breaker has been inspected for damage to contacts, arc chutes, frame and operating mechanism. Whenever shore power circuit breakers operate because of an over current, the ships forces shall be notified and the associated shore power circuits may be reenergized per local SOPS with concurrence from the ships forces.

Figure E-1 3/C Enhanced THOF Cable

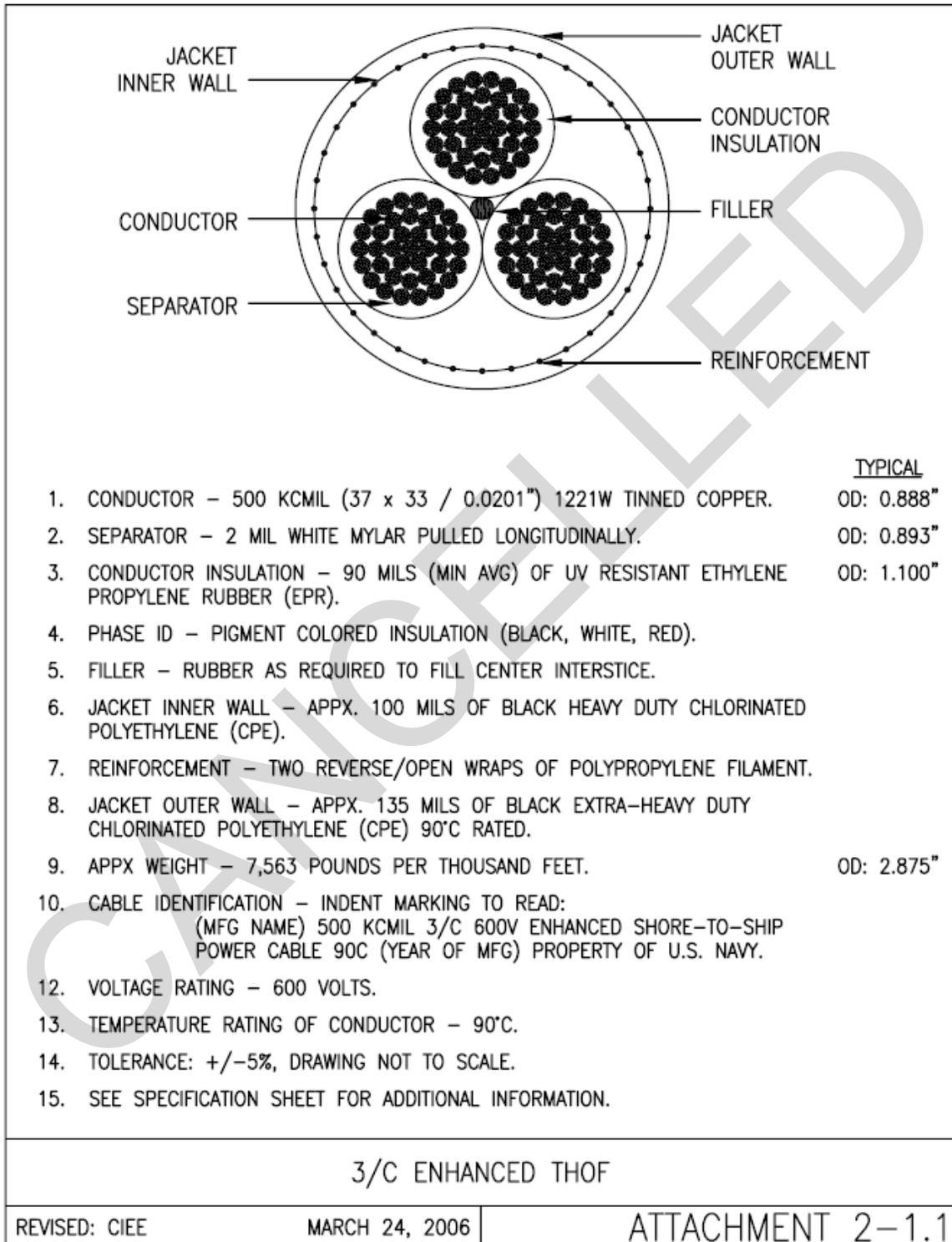
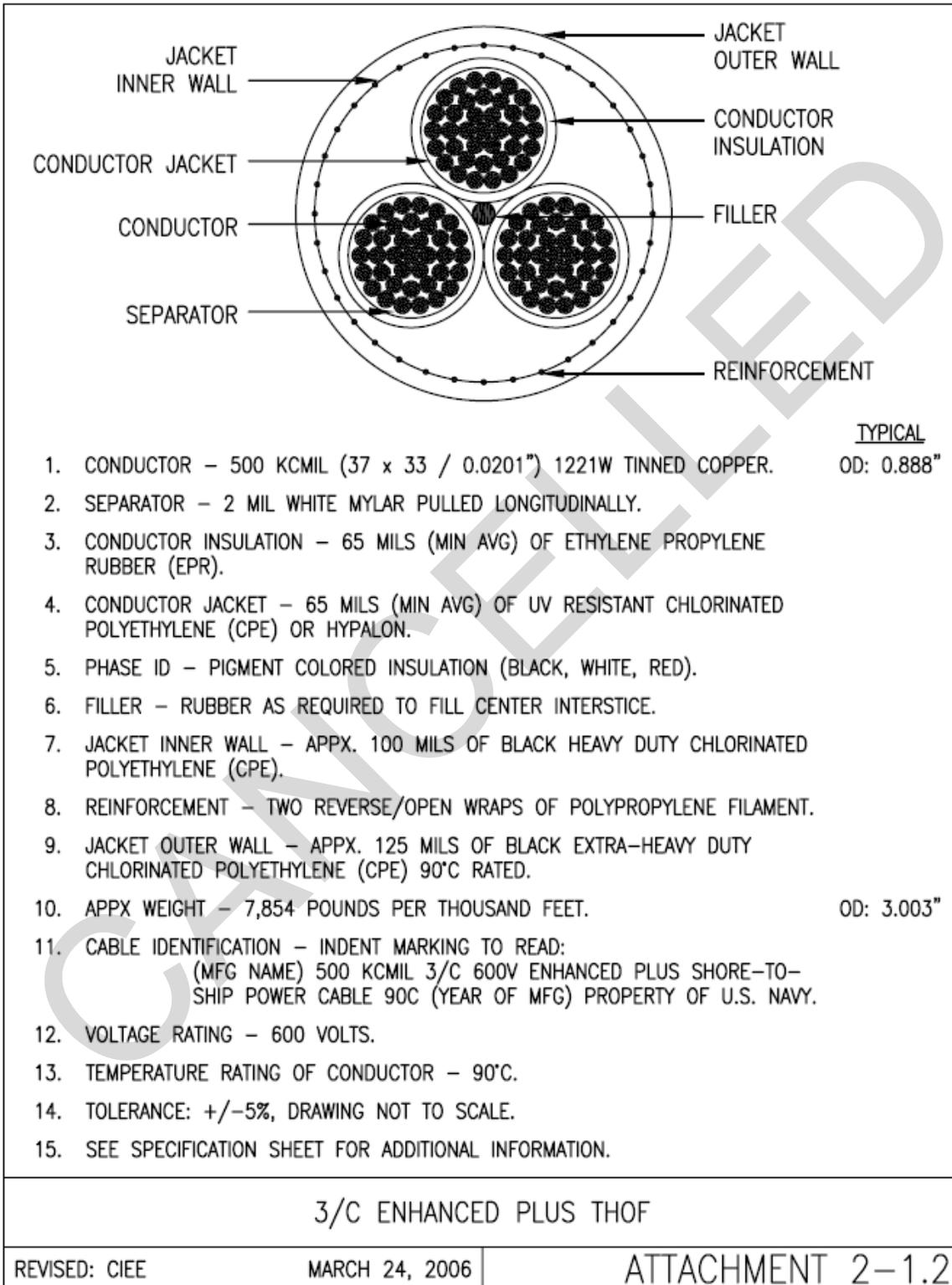


Figure E-2 3/C Enhanced Plus THOF Cable



**Figure E-3 3/C Enhanced & Enhanced Plus THOF Cable Specification**

<p><u>CONDUCTOR</u> – CLASS I, UNIDIRECTIONAL LAY-UP, MAXIMUM RESISTANCE: 0.0238 OHMS/1000FT AT 25°C.</p> <p><u>CONDUCTOR INSULATION</u> – EPR PER ICEA S-75-381. ABRASION RESISTANCE TEST IN ACCORDANCE WITH ISO 4649 – INDEX OF 50 MINIMUM. PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381. TEAR RESISTANCE, MINIMUM, 20LB/IN. UN-AGED VALUES. TENSILE STRENGTH, MINIMUM – 1200 PSI. ELONGATION AT RUPTURE, MINIMUM % – 150. AFTER AGING IN AIR 168 HOURS AT 121 ± 1°C. TENSILE STRENGTH, MINIMUM % OF UN-AGED VALUE – 75. ELONGATION AT RUPTURE, MINIMUM % OF UN-AGED VALUE – 75. LONG TERM INSULATION RESISTANCE IN 75°C WATER SHALL BE IN ACCORDANCE WITH UL 44.</p> <p><u>CONDUCTOR JACKET (ENHANCED PLUS ONLY)</u> – CPE OR HYPALON – COMPOSITE, TYPE RHH/RHW-2. ABRASION RESISTANCE IN ACCORDANCE WITH ISO 4649 – INDEX OF 50 MINIMUM. PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381. TEAR RESISTANCE, MINIMUM, 30 LB/IN. UN-AGED VALUES. TENSILE STRENGTH, MINIMUM – 2000 PSI. ELONGATION AT RUPTURE, MINIMUM % – 400.</p> <p><u>OVERALL JACKET – MOLD CURED, TWO LAYER REINFORCED JACKET FILLING THE CABLE INTERSTICES.</u> INNER WALL – HEAVY DUTY CPE. PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381. UN-AGED VALUES. TENSILE STRENGTH, MINIMUM – 1800 PSI. ELONGATION AT RUPTURE, MINIMUM % – 300. AFTER AGING IN AIR 168 HOURS AT 100 ± 1°C. TENSILE STRENGTH, MINIMUM % OF UN-AGED VALUE – 85. ELONGATION AT RUPTURE, MINIMUM % OF UN-AGED VALUE – 55. OUTER WALL – EXTRA HEAVY DUTY CPE. ABRASION RESISTANCE IN ACCORDANCE WITH ISO 4649 – INDEX OF 75 MINIMUM. PHYSICAL AND AGING TESTS IN ACCORDANCE WITH ICEA S-75-381. TEAR RESISTANCE, MINIMUM, 50 LB/IN. UN-AGED VALUES. TENSILE STRENGTH, MINIMUM – 2400 PSI. ELONGATION AT RUPTURE, MINIMUM % – 300. AFTER AGING IN AIR 168 HOURS AT 100 ± 1°C. TENSILE STRENGTH, MINIMUM % OF UN-AGED VALUE – 70. ELONGATION AT RUPTURE, MINIMUM % OF UN-AGED VALUE – 55.</p>		
<p>ENHANCED &amp; ENHANCED PLUS THOF SPECIFICATION</p>		
REVISED: CIEE	JANUARY 31, 2007	ATTACHMENT 2-1.3

**Figure E-3 3/C Enhanced & Enhanced Plus THOF Cable Specification**

<p><u>ASSEMBLY</u> ENHANCED THOF CABLE SHALL HAVE INSULATED CONDUCTORS. ENHANCED PLUS THOF CABLE SHALL HAVE INSULATED AND JACKETED CONDUCTORS. SEE DRAWINGS FOR DIMENSIONS AND SUPPLEMENTAL INFORMATION.</p> <p>THREE CONDUCTORS SHALL BE CABLED WITH A MAXIMUM LAY LENGTH OF 26 INCHES. EXCEPT FOR A CENTER EXTRUDED RUBBER ROD FILLER, NO OTHER FILLERS ARE PERMITTED. NO ASSEMBLY BINDER TAPE IS TO BE USED. MOLD RELEASE AGENTS, IF USED SHALL NOT CONTAIN SILICONE OR WAX.</p> <p><u>FUNCTIONAL TESTS</u> THE GOVERNMENT RESERVES THE RIGHT TO WITNESS ANY OR ALL CABLE TESTS. ONCE FUNCTIONAL TESTING HAS BEGUN, ALL TESTS MUST BE COMPLETED IN NO MORE THAN 36 HOURS. FUNCTIONAL TESTS ARE REQUIRED USING A TEST CABLE AS DESCRIBED BELOW. TESTS SHALL BE CONDUCTED AFTER THE CABLE HAS BEEN EXPOSED TO THE SPECIFIED TEST TEMPERATURE FOR AT LEAST 8 HOURS. THE FUNCTIONAL TESTS SHALL BE PERFORMED IN THE FOLLOWING ORDER USING THE SAME PIECE OF CABLE:</p> <ol style="list-style-type: none"><li>1. DIELECTRIC PRE-FLEX TEST.</li><li>2. SUMMER FLEXIBILITY WITH NATURAL BEND.</li><li>3. SUMMER FLEXIBILITY AGAINST NATURAL BEND.</li><li>4. WINTER FLEXIBILITY WITH NATURAL BEND.</li><li>5. WINTER FLEXIBILITY AGAINST NATURAL BEND.</li><li>6. CUT-BACK.</li><li>7. DIELECTRIC POST-FLEX TEST.</li></ol> <p><u>TEST CABLE DESCRIPTION</u> THE TEST CABLE WILL BE 12 FEET IN LENGTH CUT FROM A CABLE WITH A MINIMUM LENGTH OF 100 FEET, ROLLED ONTO A CABLE REEL FOR AT LEAST 168 HOURS WHOSE SPOOL DIAMETER DOES NOT EXCEED 3 FEET. THE TEST CABLE WILL BE CUT FROM THE LAYER OF CABLE IN CONTACT WITH THE SPOOL. AFTER THE DIELECTRIC PRE-TEST EACH END WILL BE SEALED TO PREVENT MOISTURE INFILTRATION.</p>	
<p>ENHANCED &amp; ENHANCED PLUS THOF SPECIFICATION (CONT'D)</p>	
REVISED: CIEE	MARCH 24, 2006
<p>ATTACHMENT 2-1.4</p>	

**Figure E-3 3/C Enhanced & Enhanced Plus THOF Cable Specification****FLEXIBILITY TEST**

ALL FLEXIBILITY TESTS WILL BE PERFORMED BY LAYING THE TEST CABLE ON A 20 INCH DIAMETER SHEAVE OR DRUM (IE WHEEL) AND LIFTING IT VERTICALLY UNTIL THE CABLE HANGS FREE IN AIR. THE PLACEMENT OF THE CABLE ONTO THE WHEEL WILL ALLOW APPROXIMATELY ONE-HALF OF THE CABLE TO HANG DOWN ON EACH SIDE. AS THE CABLE HANGS FREE, ATTACH 80 POUNDS TO EACH END AND MEASURE TANGENTIALLY (IE PERPENDICULAR TO VERTICAL) THE SHORTEST DISTANCE BETWEEN THE CABLE MEASURED AT THE BOTTOM OF THE WHEEL. THE CABLE SHALL HANG FOR NO MORE THAN 30 SECONDS BEFORE THE MEASUREMENT IS TAKEN. NO FORCE TENDING TO BRING THE CABLE ON EACH SIDE OF THE WHEEL CLOSER TOGETHER WILL BE PERMITTED. ONLY THE WEIGHT OF THE CABLE AND THE TEST WEIGHTS WILL BEND IT AROUND THE TOP OF THE WHEEL.

**DIMENSIONS BETWEEN CABLE AT BOTTOM OF WHEEL.**

SUMMER: 25 INCHES MAXIMUM AT 25°C,  $\pm 2^\circ\text{C}$ .

WINTER: 28 INCHES MAXIMUM AT 5°C,  $\pm 2^\circ\text{C}$ .

**CUT-BACK TEST**

NOT LESS THAN 24 INCHES OF THE CABLE JACKET WILL BE REMOVED FROM BOTH ENDS OF THE TEST CABLE USING A KNIFE, 10 INCH CHANNEL LOCK OR VICE GRIP TYPE PLIERS, AND 8 INCH NEEDLE NOSE PLIERS. REMOVAL OF THE JACKET SHALL BE ACCOMPLISHED WITHOUT THE APPLICATION OF HEAT TO THE JACKET AT ROOM TEMPERATURE OF 20°C  $\pm 2^\circ\text{C}$ . VERIFY THE FOLLOWING:

NO BONDING OF CONDUCTOR INSULATION (OR CONDUCTOR JACKET) TO CABLE JACKET  
 NO REMOVAL OF CONDUCTOR INSULATION (OR CONDUCTOR JACKET) BY TEARING  
 BOND BETWEEN INNER WALL AND OUTER WALL OF OVERALL JACKET SHALL BE STOCK TEARING.

**DIELECTRIC TESTS**

DIELECTRIC TESTS (BOTH PRE AND POST FLEXIBILITY TESTING), PER ICEA T-27-581.

AC HI POT; 9.5 KV FOR 5 MINUTES.

INSULATION RESISTANCE: NOT LESS THAN 100 MEG-OHMS.

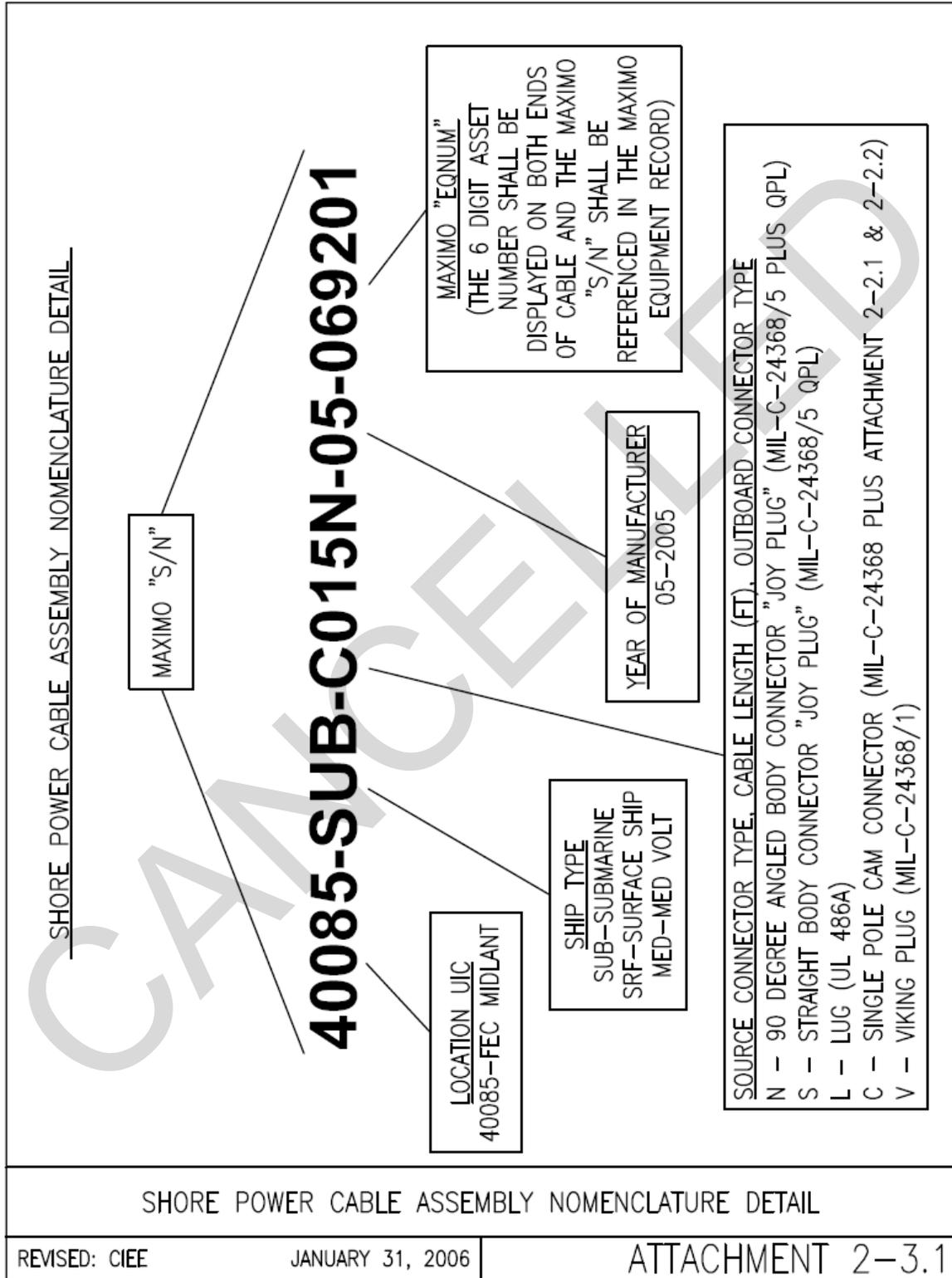
ENHANCED & ENHANCED PLUS THOF SPECIFICATION (CONT'D)

REVISED: CIEE

JANUARY 31, 2006

ATTACHMENT 2-1.5

Figure E-4 Shore Power Cable Assembly Nomenclature Detail



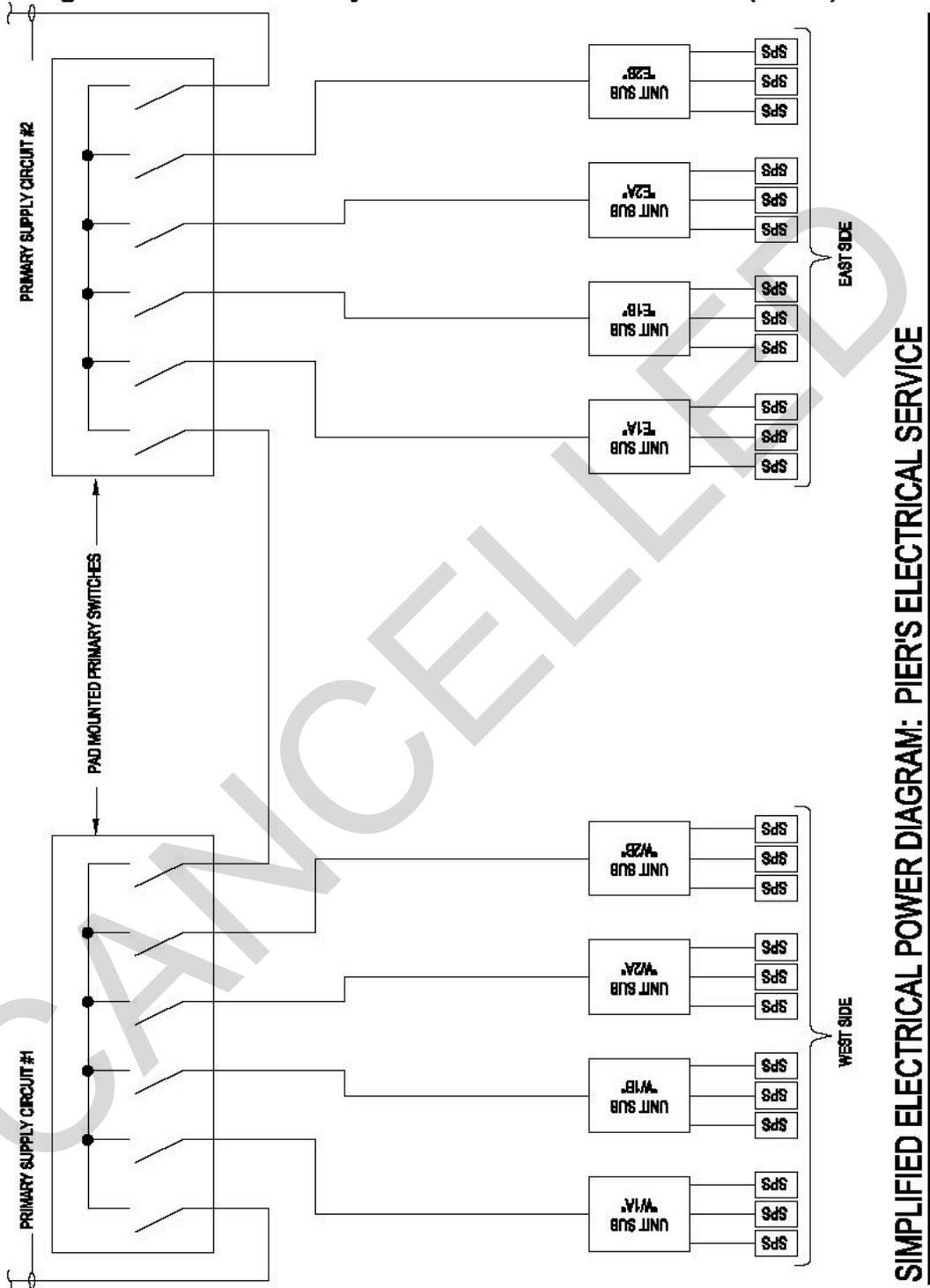
/4/

**APPENDIX F  
TYPICAL ELECTRICAL DIAGRAMS AND DETAILS**

- Figure F-1 Electrical System for a Double-Deck Pier
- Figure F-2 Pier Electrical Distribution
- Figure F-3 Portable Substation
- Figure F-4 Ship Service Outlet Assembly
- Figure F-5 Single Pole Connector Details
- Figure F-6 Pier Electrical Distribution for Temporary Services

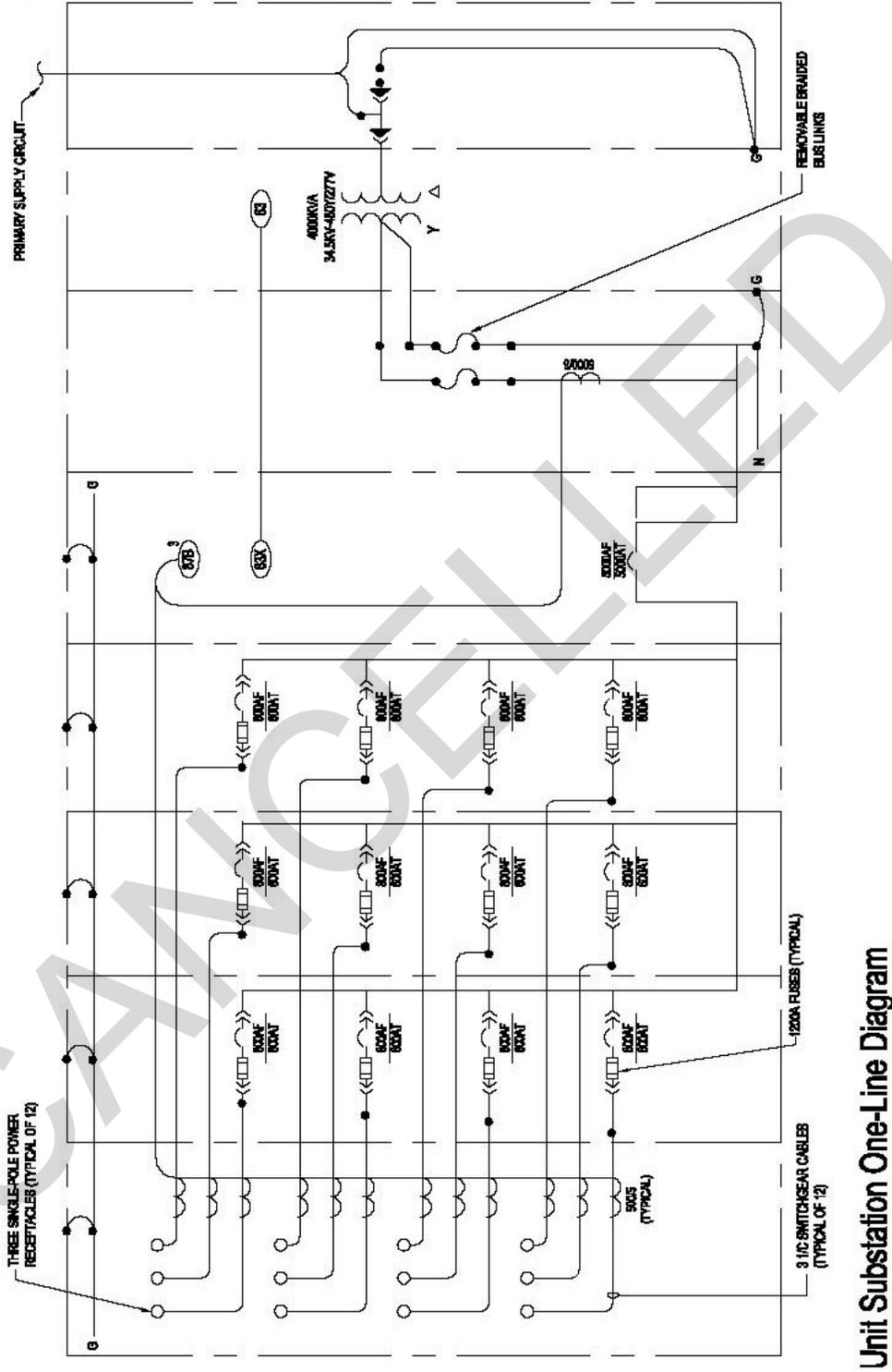
CANCELLED

Figure F-1A Electrical System for a Double-Deck Pier (1 of 9)



**SIMPLIFIED ELECTRICAL POWER DIAGRAM: PIER'S ELECTRICAL SERVICE**

Figure F-1B Electrical System for a Double-Deck Pier (2 of 9)



Unit Substation One-Line Diagram

Figure F-1C Electrical System for a Double-Deck Pier (3 of 9)

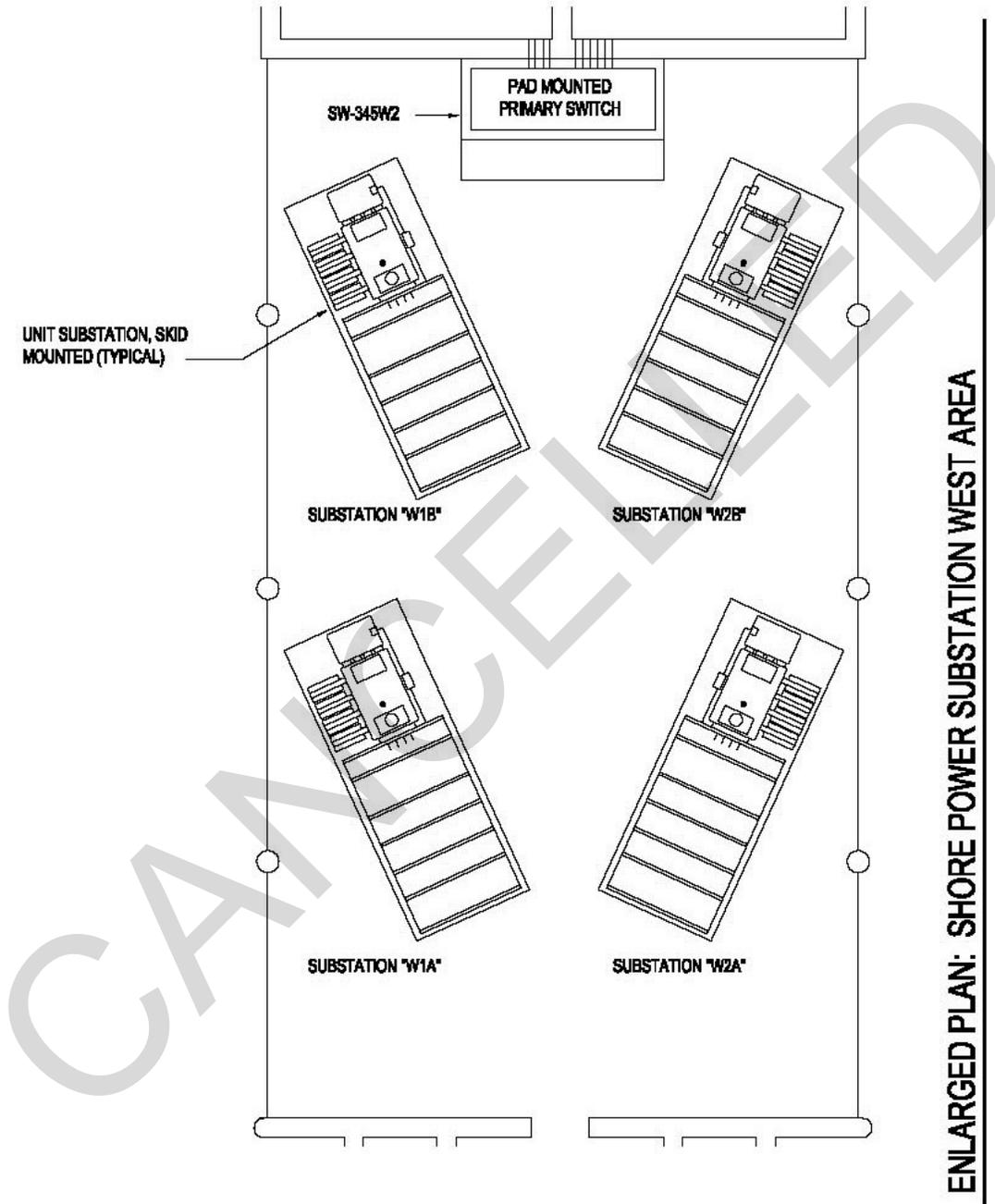


Figure F-1D Electrical System for a Double-Deck Pier (4 of 9)

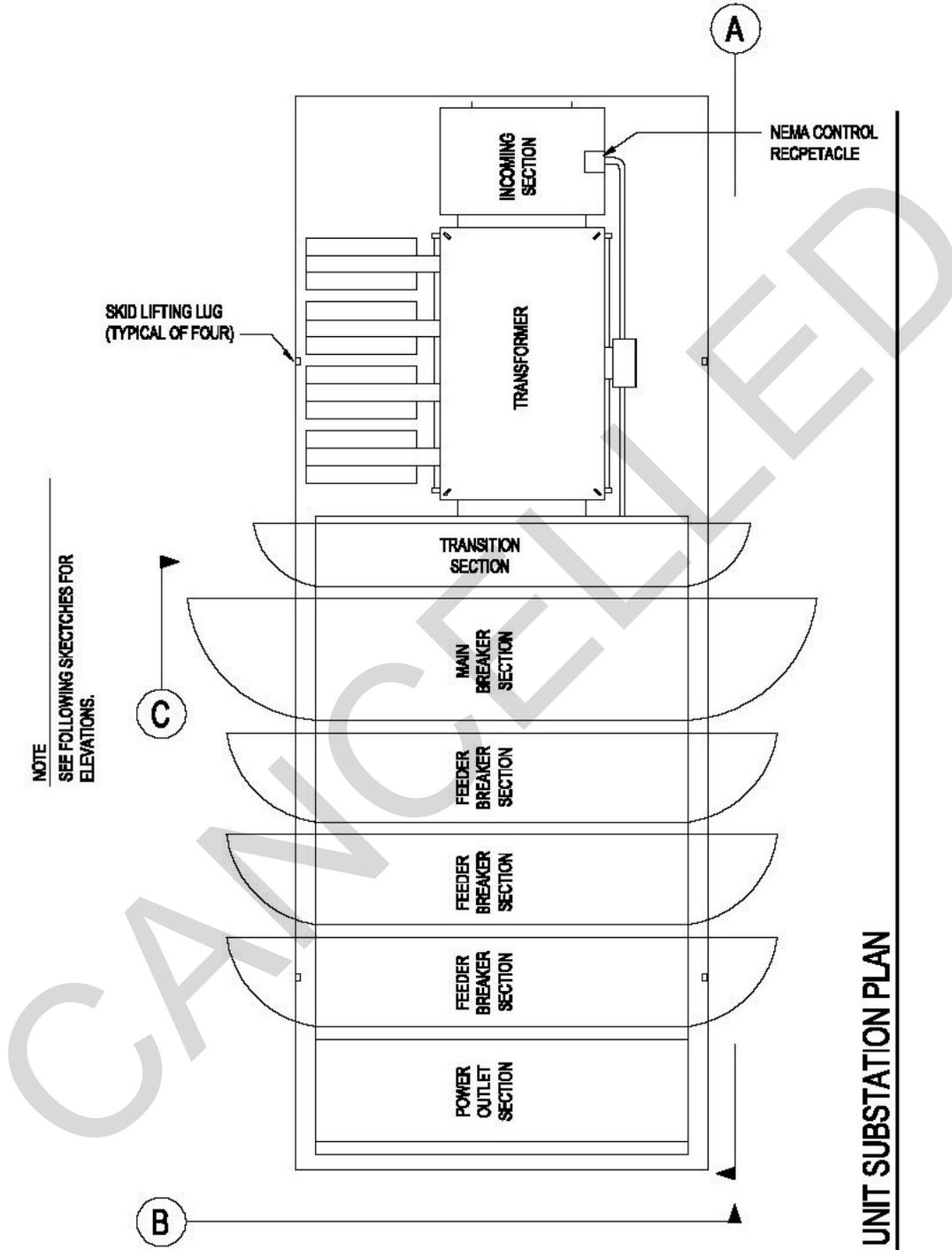


Figure F-1E Electrical System for a Double-Deck Pier (5 of 9)

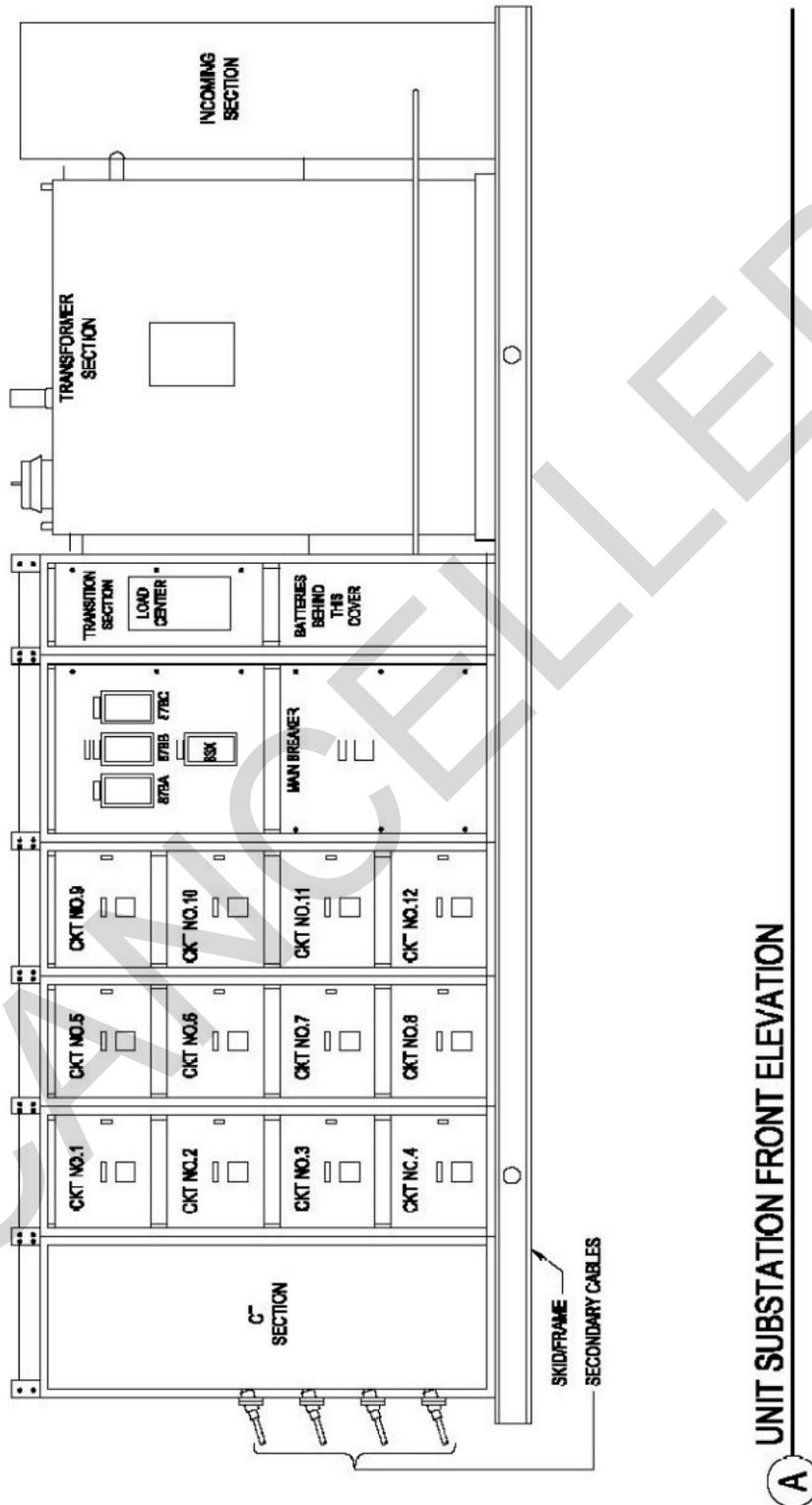


Figure F-1F Electrical System for a Double-Deck Pier (6 of 9)

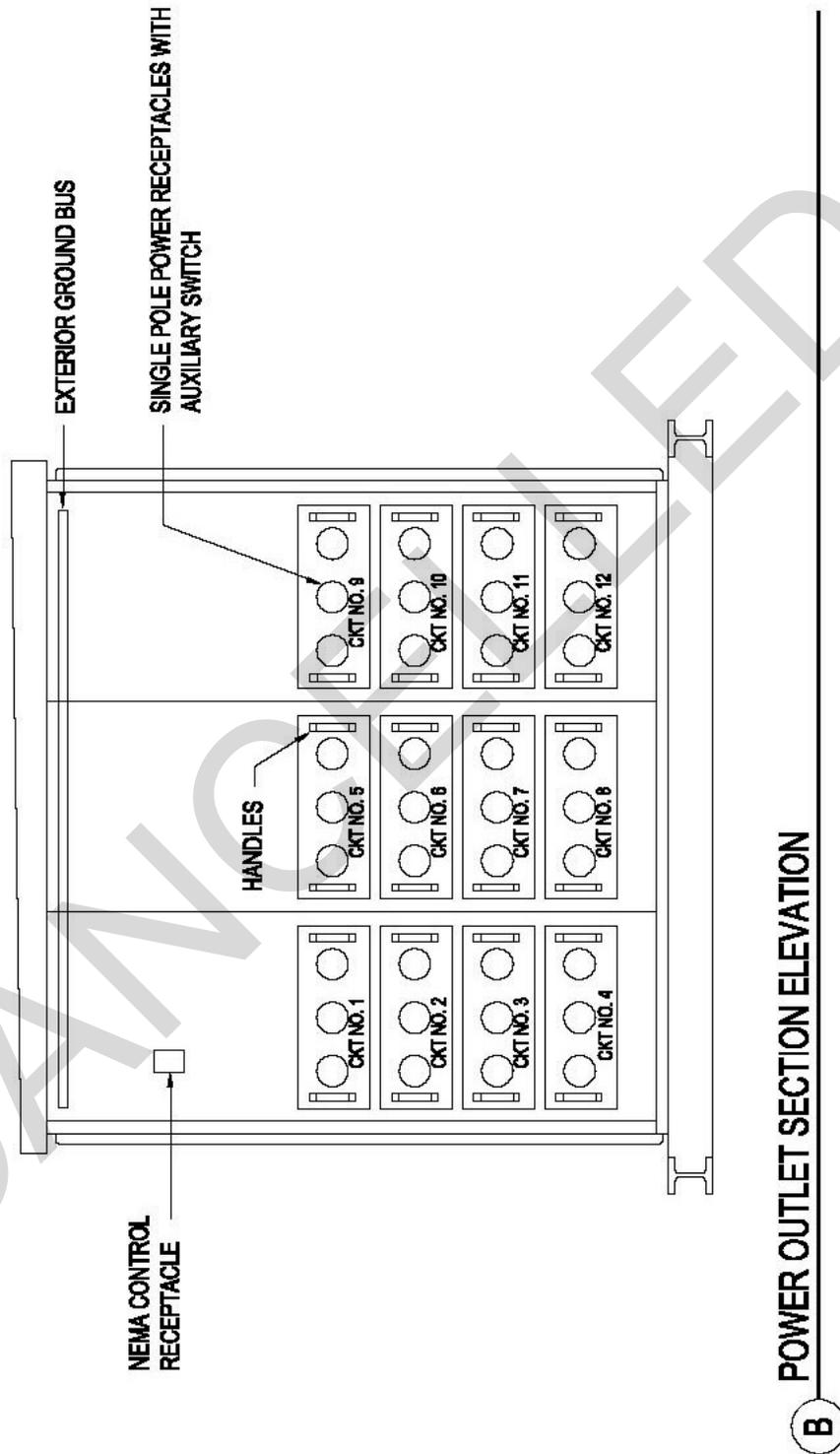
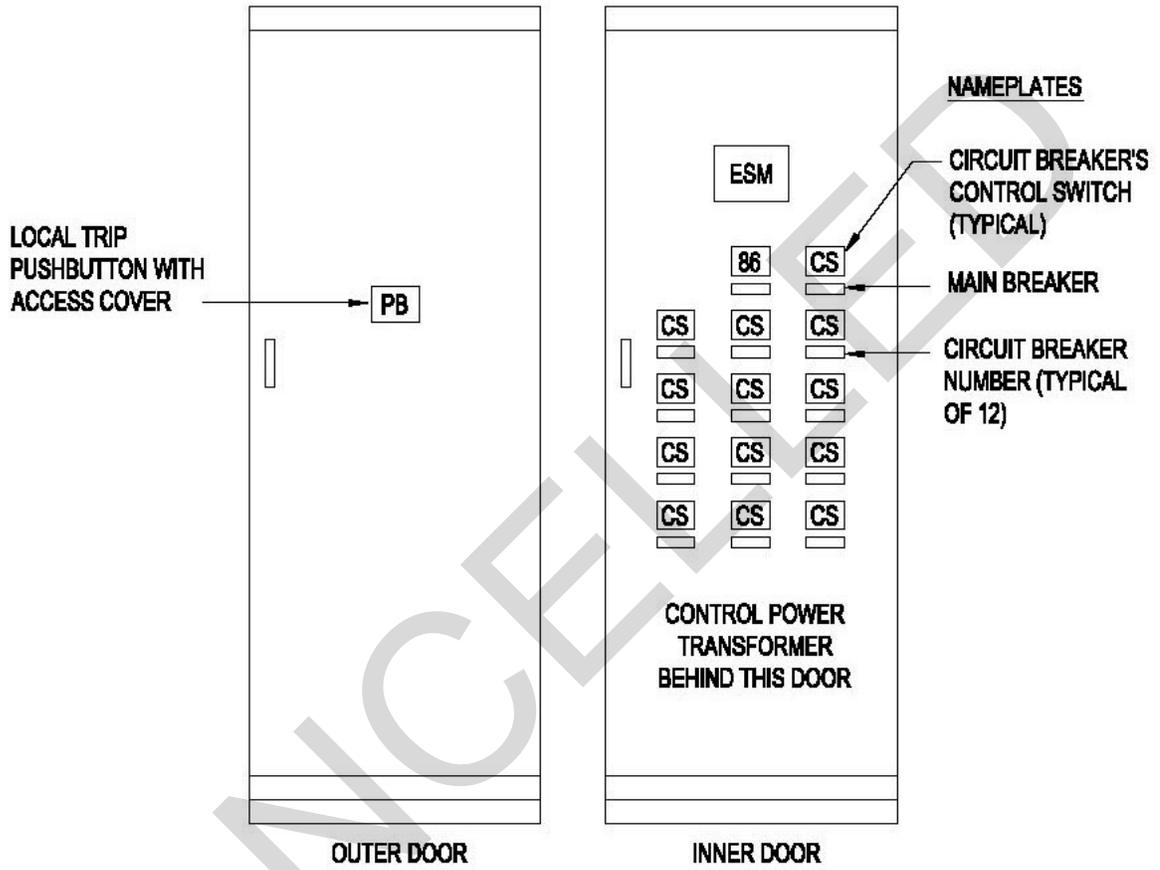
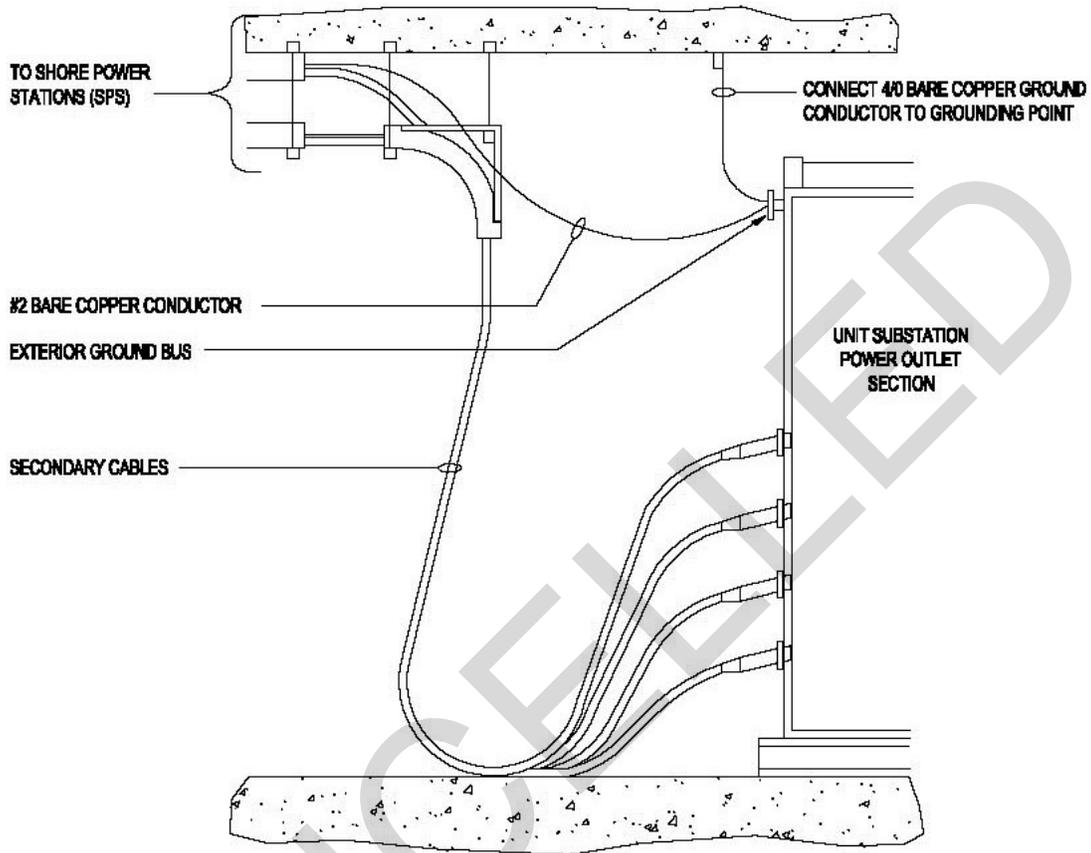


Figure F-1G Electrical System for a Double-Deck Pier (7 of 9)



**C** CONTROL PANEL ELEVATION

Figure F-1H Electrical System for a Double-Deck Pier (8 of 9)



**TYPICAL POWER OUTLET CONNECTIONS**

Figure F-1I Electrical System for a Double-Deck Pier (9 of 9)

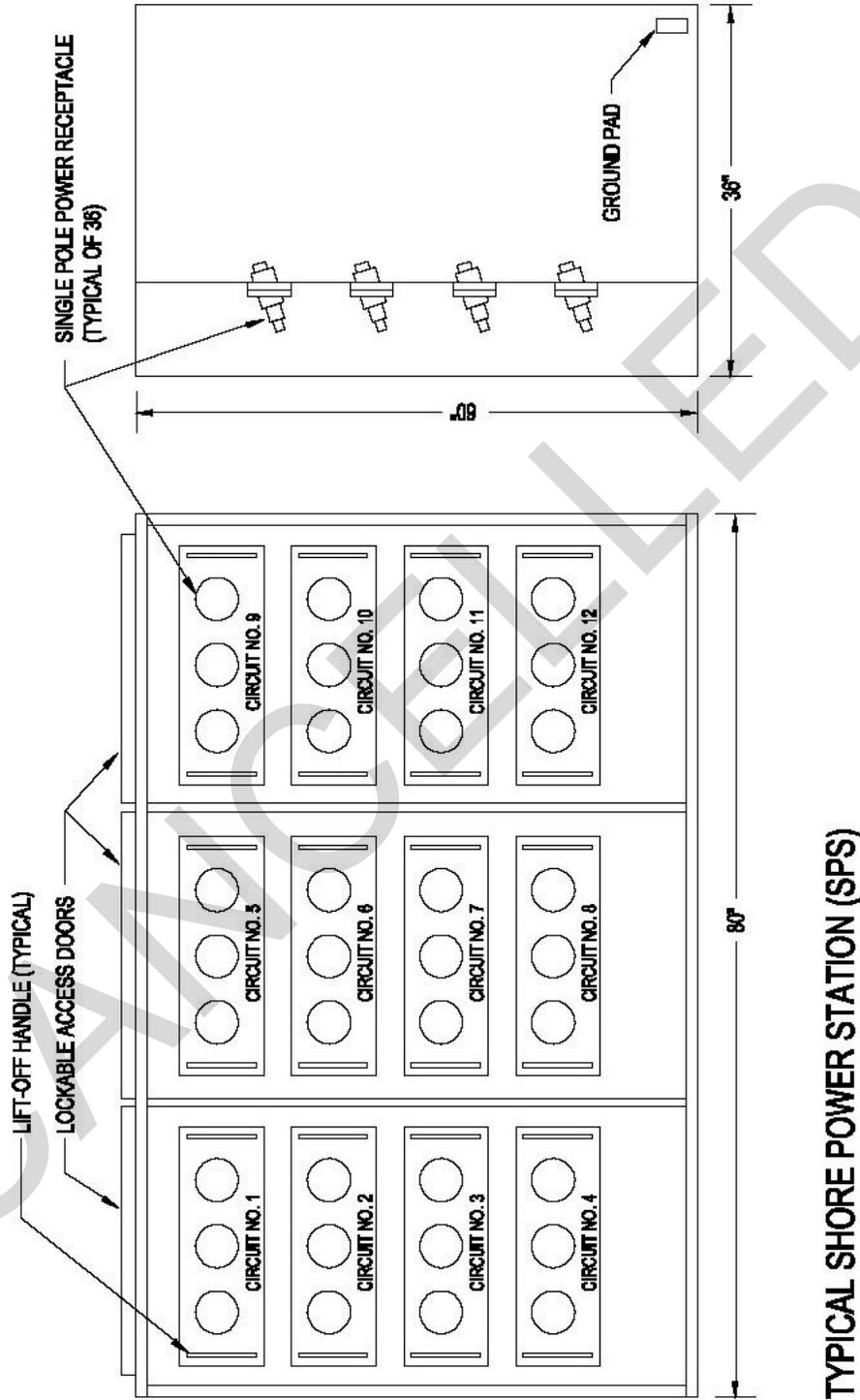
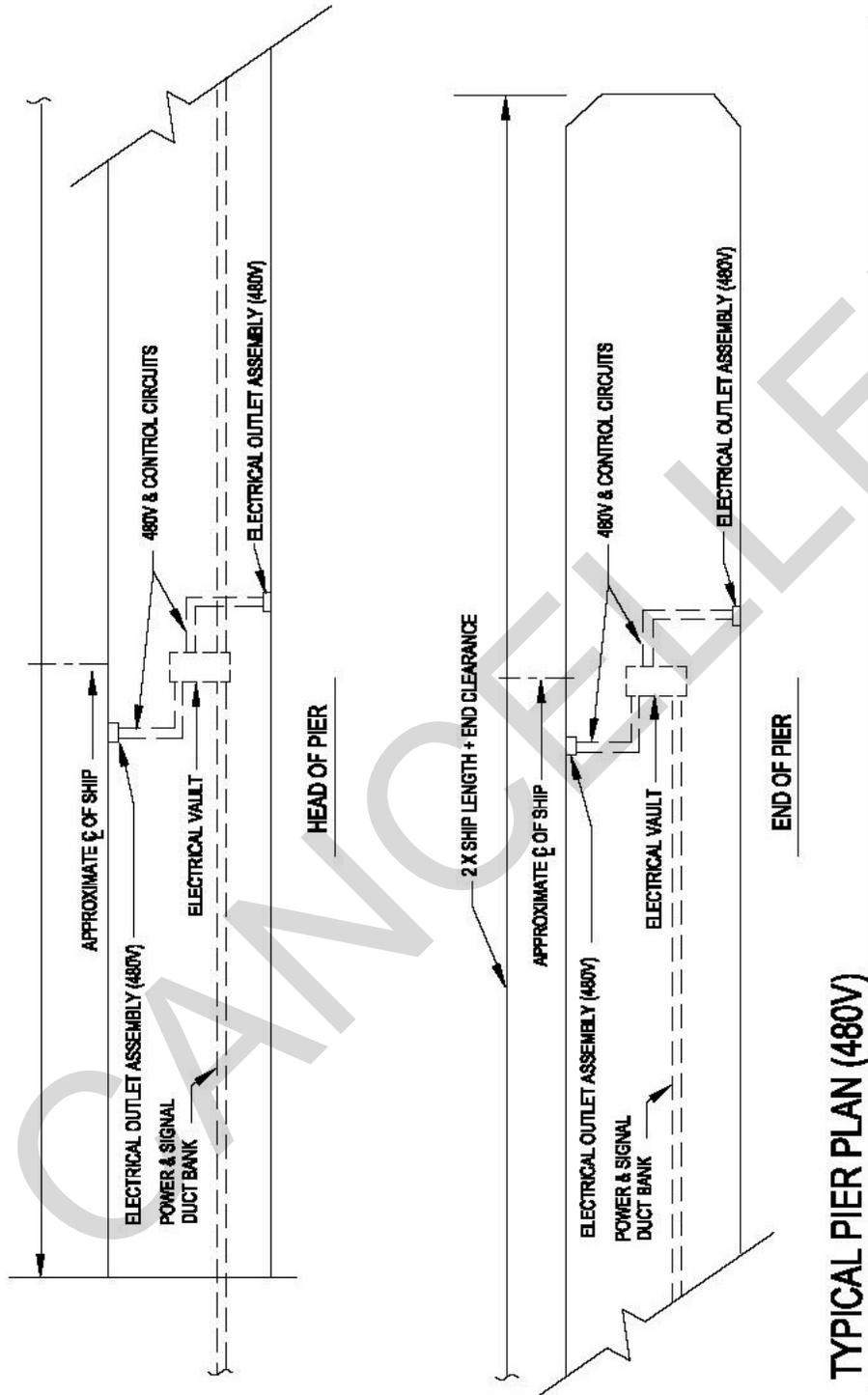


Figure F-2A Pier Electrical Distribution: Typical Vault System (1 of 5)

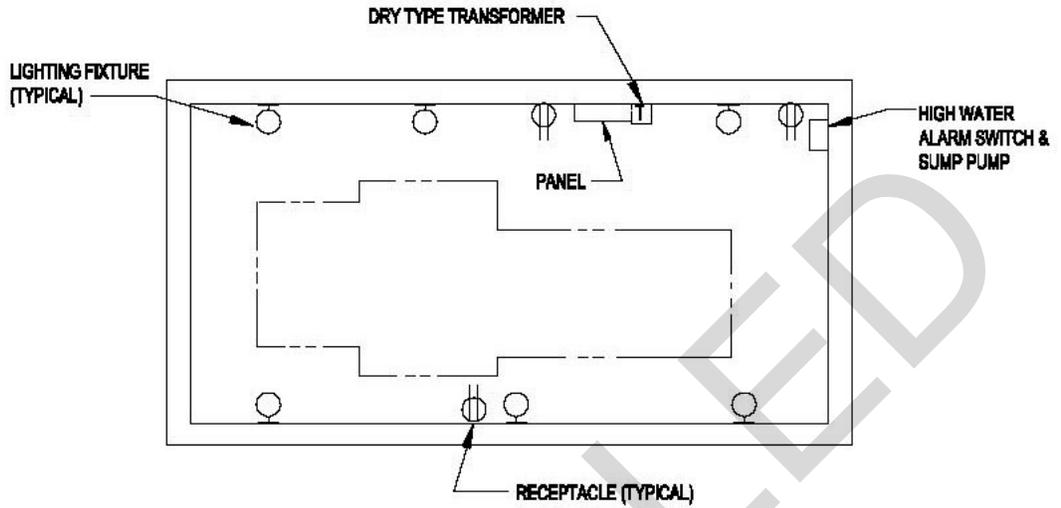


**TYPICAL PIER PLAN (480V)**

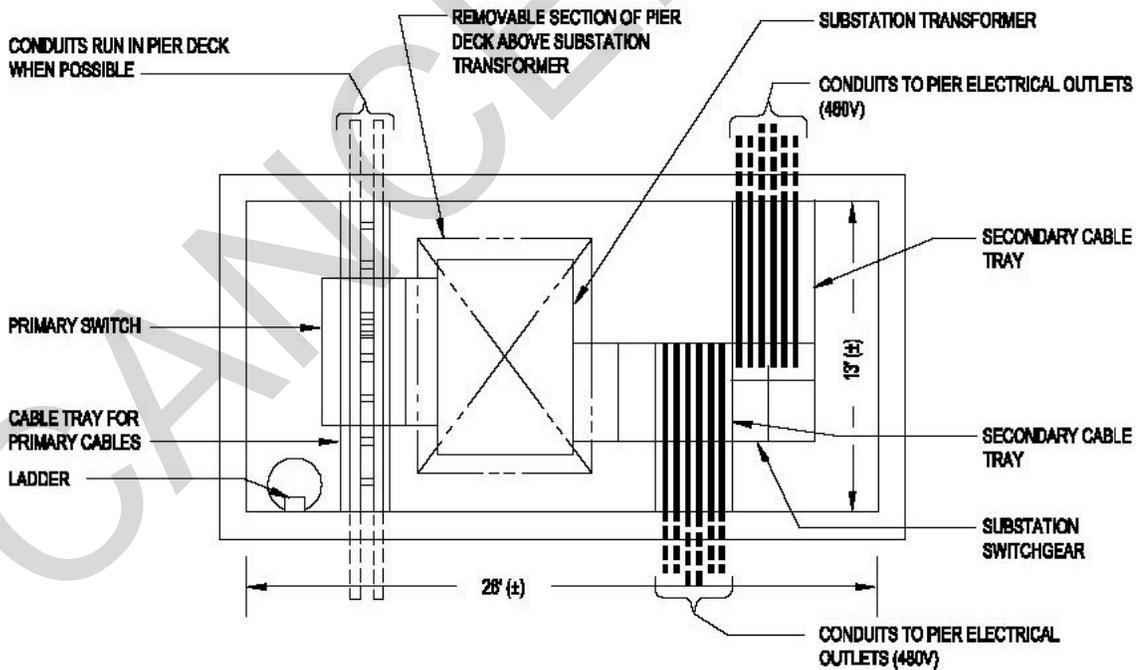
**NOTES**

1. THIS DRAWING IS FOR REFERENCE, PLANING AND ESTIMATING PURPOSES ONLY.
2. IN NEW CONSTRUCTION, PROVIDE CONDUITS IN PIER DECK. IN REHABILITATION PROJECTS, PROVIDE CONDUITS BENEATH PIER DECK.
3. PROVIDE VAULTS WITH HIGH WATER ALARMS AND HIGH TEMPERATURE TRANSFORMER ALARMS.
4. SET SUBSTATION INCLUDING SWITCHGEAR ON 6" HIGH CONCRETE PAD.
5. THIS PLATE IS BASED ON A 3750 KVA SUBSTATION WITH 15 KV CLASS INCOMING PRIMARY AND SERVING 16-400 AMPERE, 480 VOLT SHORE-TO-SHIP CIRCUITS.

Figure F-2B Pier Electrical Distribution: Typical Vault System (2 of 5)



LIGHTING AND SMALL POWER PLAN



ELECTRICAL VAULT PLAN

Figure F-2C Pier Electrical Distribution: Typical Vault System (3 of 5)

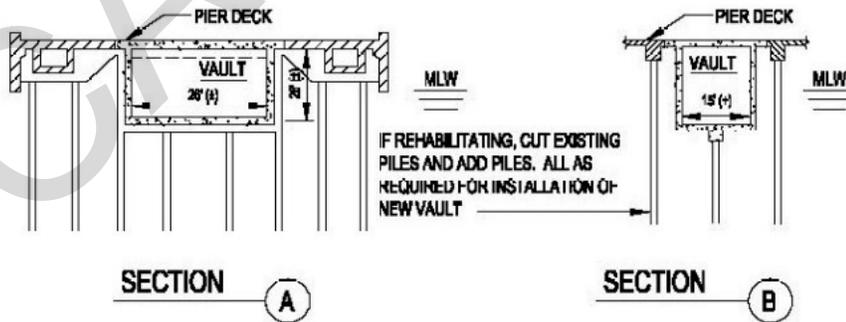
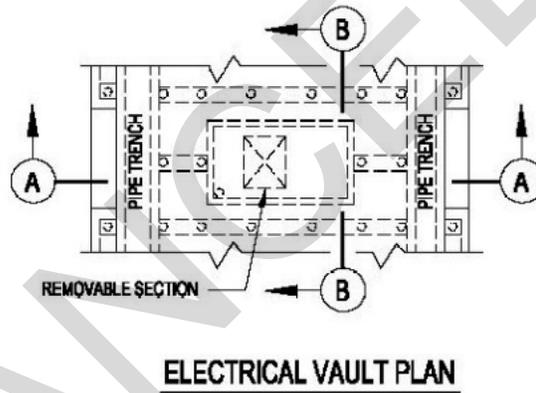
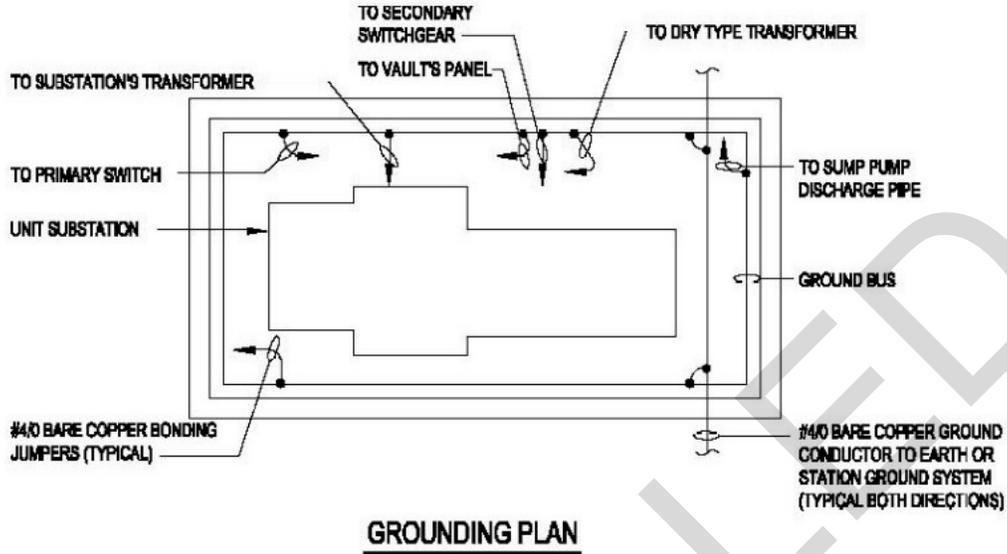


Figure F-2D Pier Electrical Distribution: Typical Vault System (4 of 5)

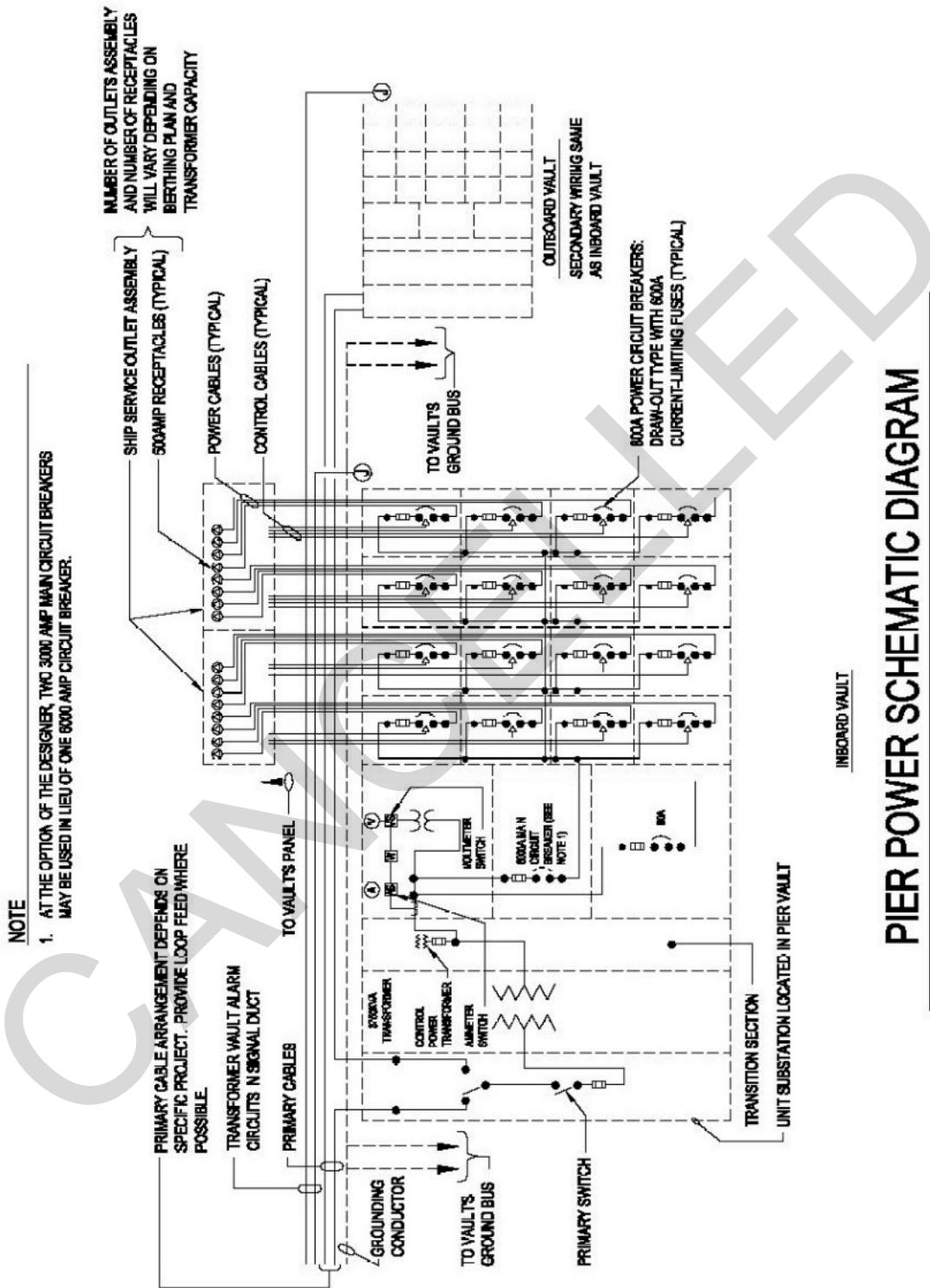


Figure F-2E Pier Electrical Distribution: Typical Vault System (5 of 5)

**NOTE**  
 STRUCTURAL ASPECTS SHOWN FOR REFERENCE ONLY.  
 SIZE AND CONSTRUCTION OF VAULT WILL VARY.

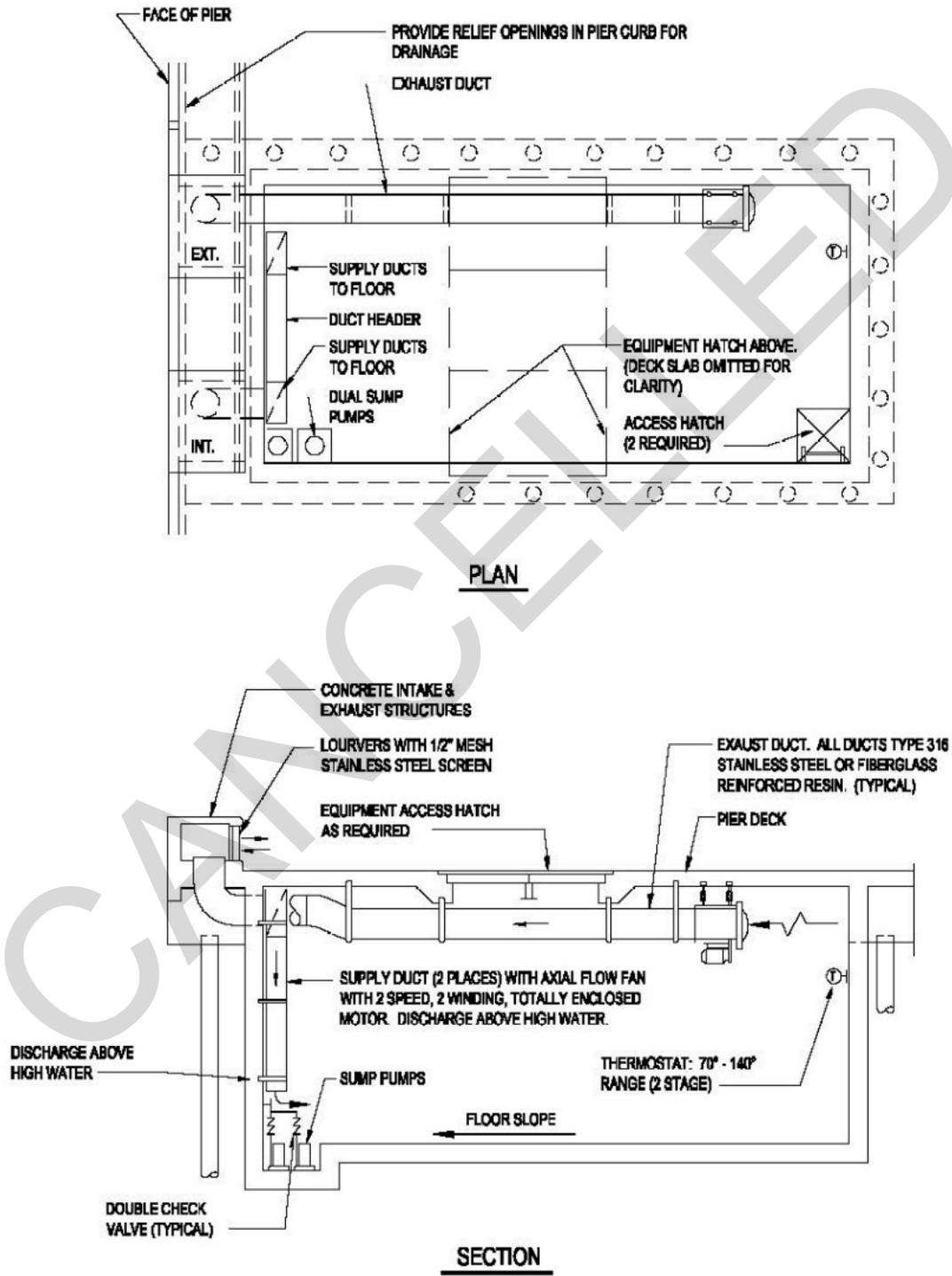
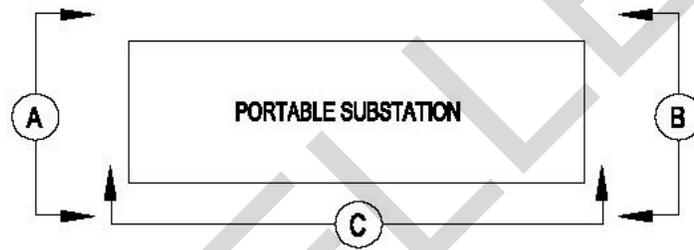


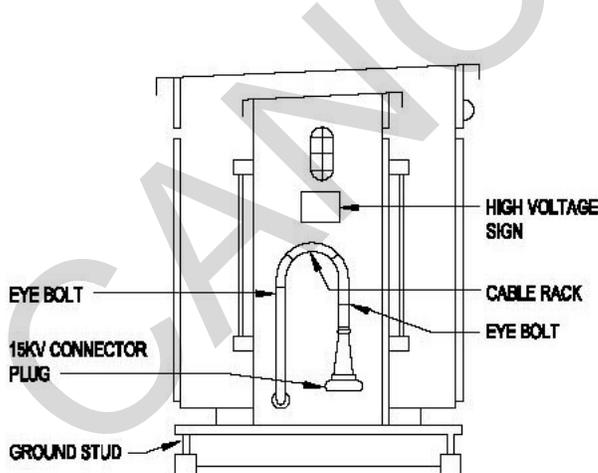
Figure F-3A Portable Substation (1 of 3)

**NOTES**

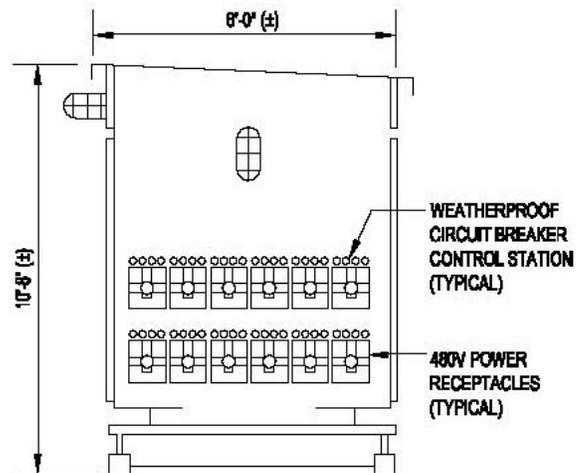
1. DRAWING IS FOR REFERENCE, PLANNING AND ESTIMATING PURPOSES ONLY.
2. DRAWING IS DESIGNED FOR A 3 PHASE, 13.2KV GROUNDED NEUTRAL SYSTEM. THE CONNECTORS ARE NOT AVAILABLE FOR UNGROUNDED NEUTRAL SYSTEMS ABOVE 8.32KV.
3. THE NUMBER OF CIRCUIT BREAKERS AND RECEPTACLES AND THE LENGTH AND WEIGHT OF THE SUBSTATION WILL VARY DEPENDING ON THE TRANSFORMER KVA SIZE. THE TRANSFORMER SIZE WILL NORMALLY VARY FROM 1000KVA TO 2500KVA, THE NUMBER OF CIRCUIT BREAKERS AND RECEPTACLES FROM 8 TO 12, THE SUBSTATION LENGTH FROM 22' TO 28', AND THE SUBSTATION WEIGHT FROM APPROXIMATELY 22,500 POUNDS TO 33,500 POUNDS.



**KEY PLAN**

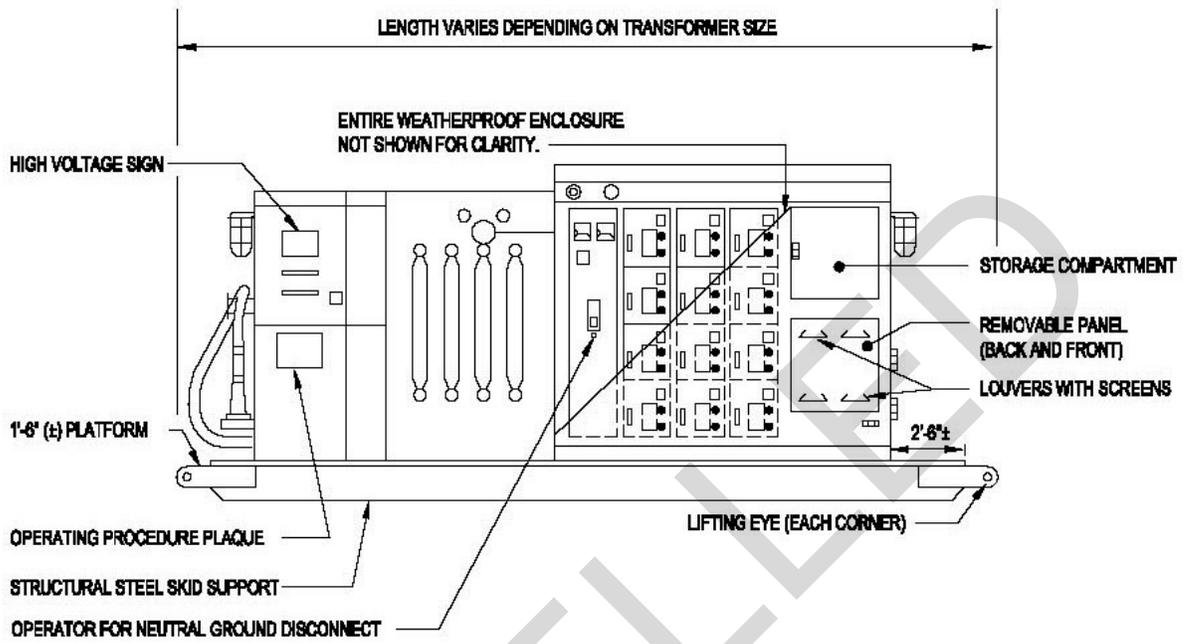


**ELEVATION A-A (PRIMARY INPUT)**

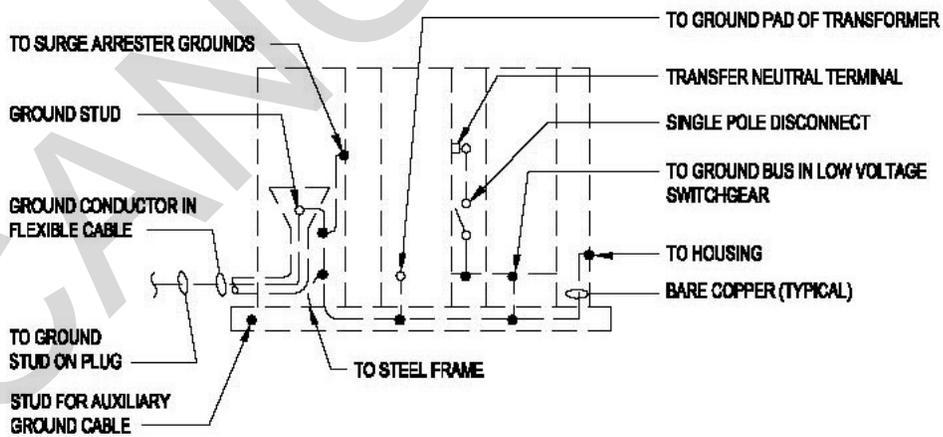


**ELEVATION B-B (SECONDARY OUTPUT)**

Figure F-3B Portable Substation (2 of 3)

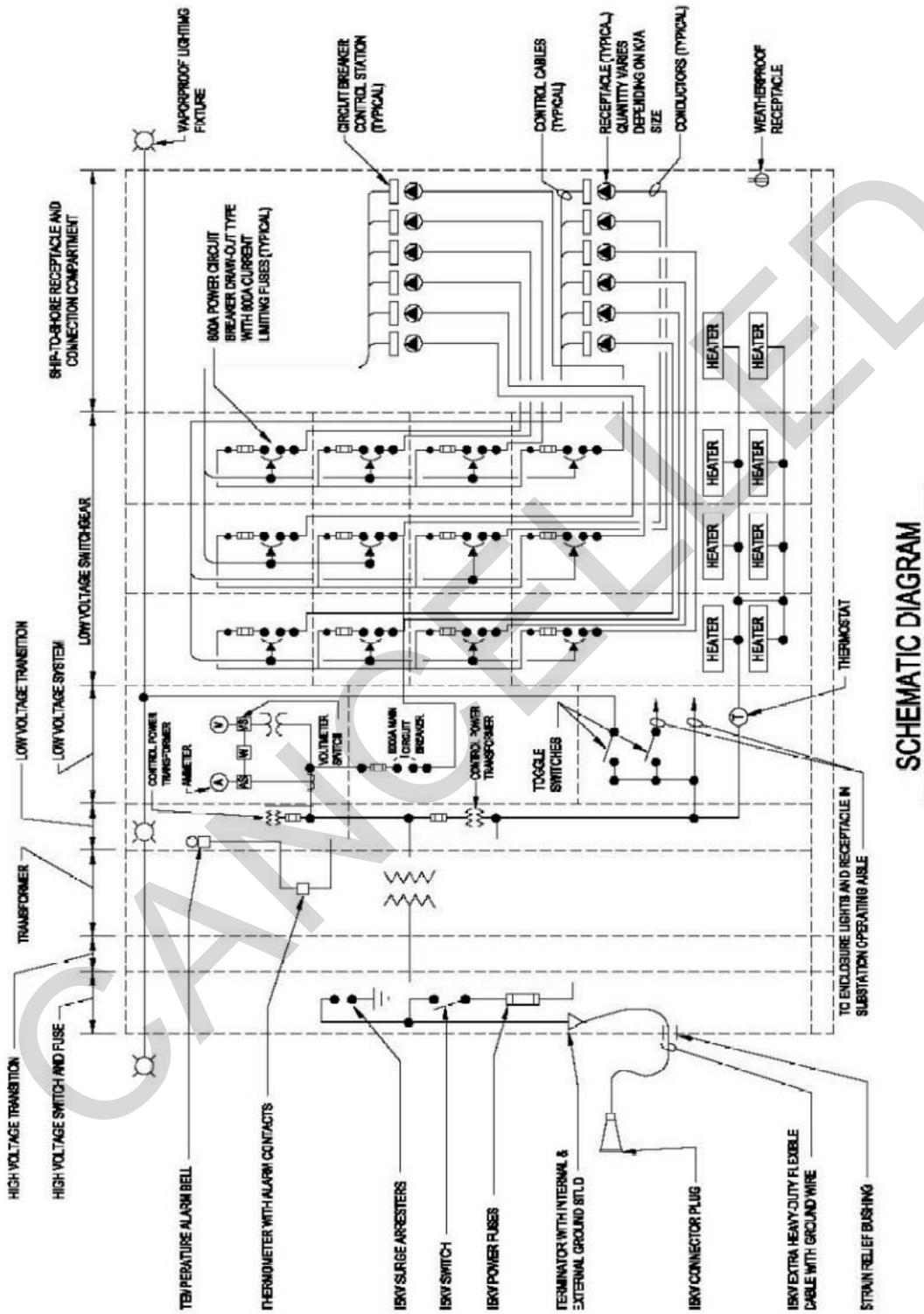


ELEVATION C-C (FRONT VIEW)



GROUNDING SCHEMATIC

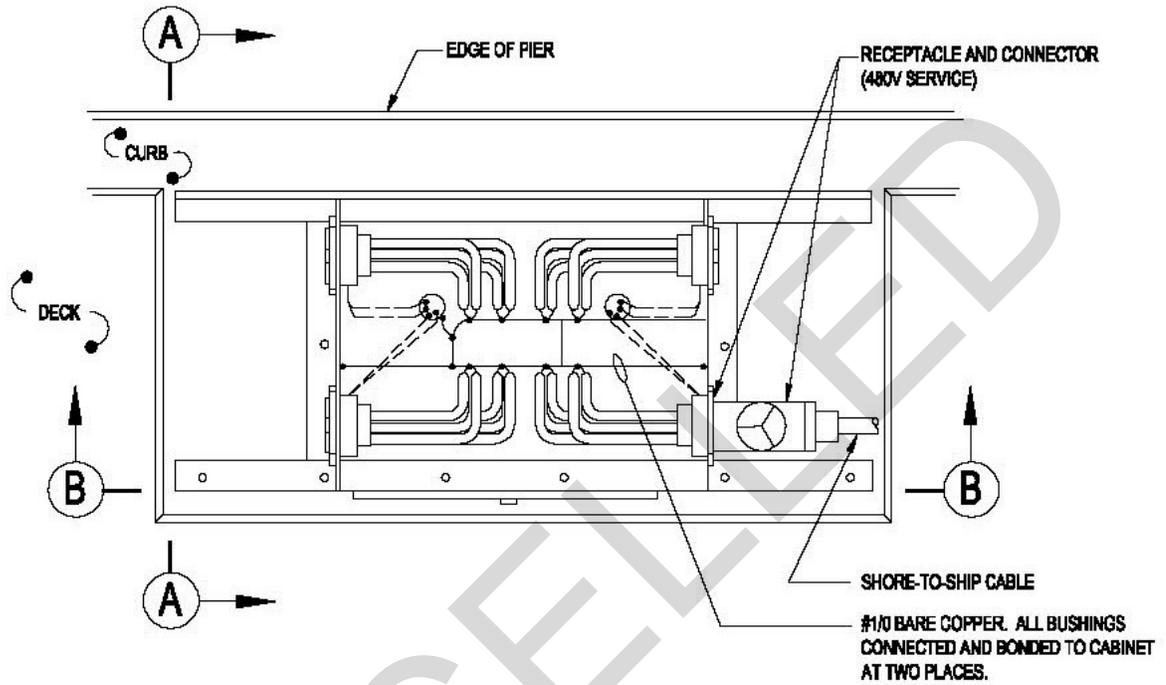
Figure F-3C Portable Substation (3 of 3)



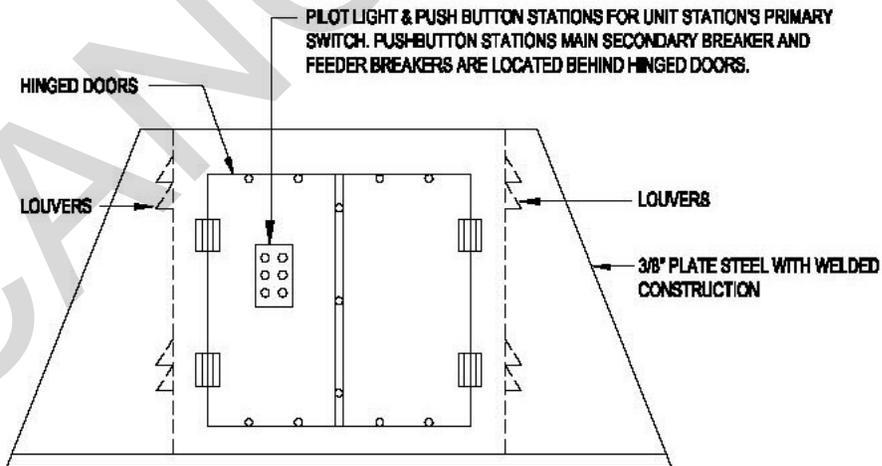
**SCHEMATIC DIAGRAM**

Figure F-4A Ship Service Outlet Assembly (1 of 2)

NOTE:  
 SEE NEXT PAGE FOR SECTION CUTS.



PLAN



FRONT ELEVATION (REAR SIMILAR)

Figure F-4B Ship Service Outlet Assembly (2 of 2)

**NOTE**

SEE PREVIOUS PAGE FOR DESCRIPTION  
WHERE SECTIONS ARE CUT.

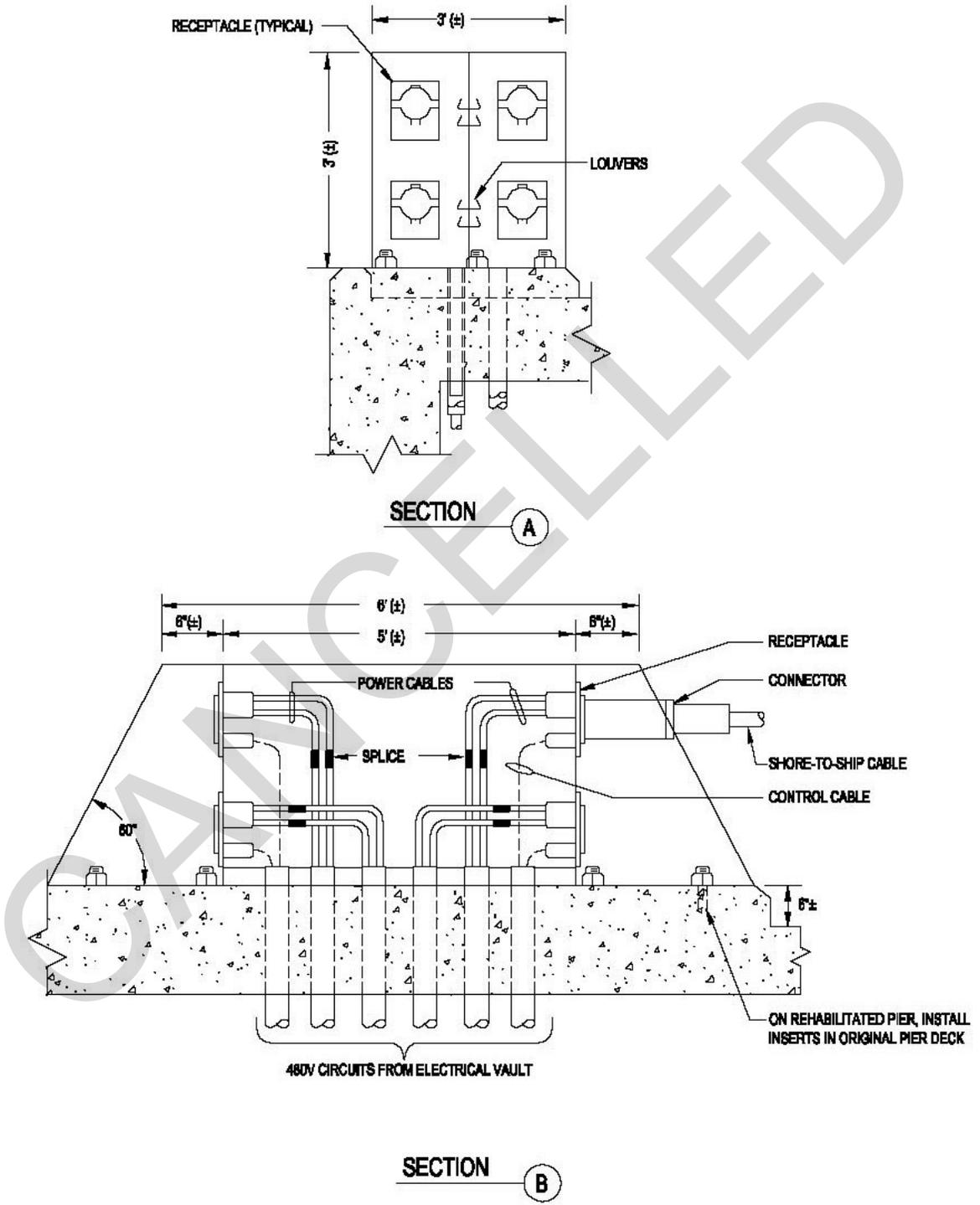
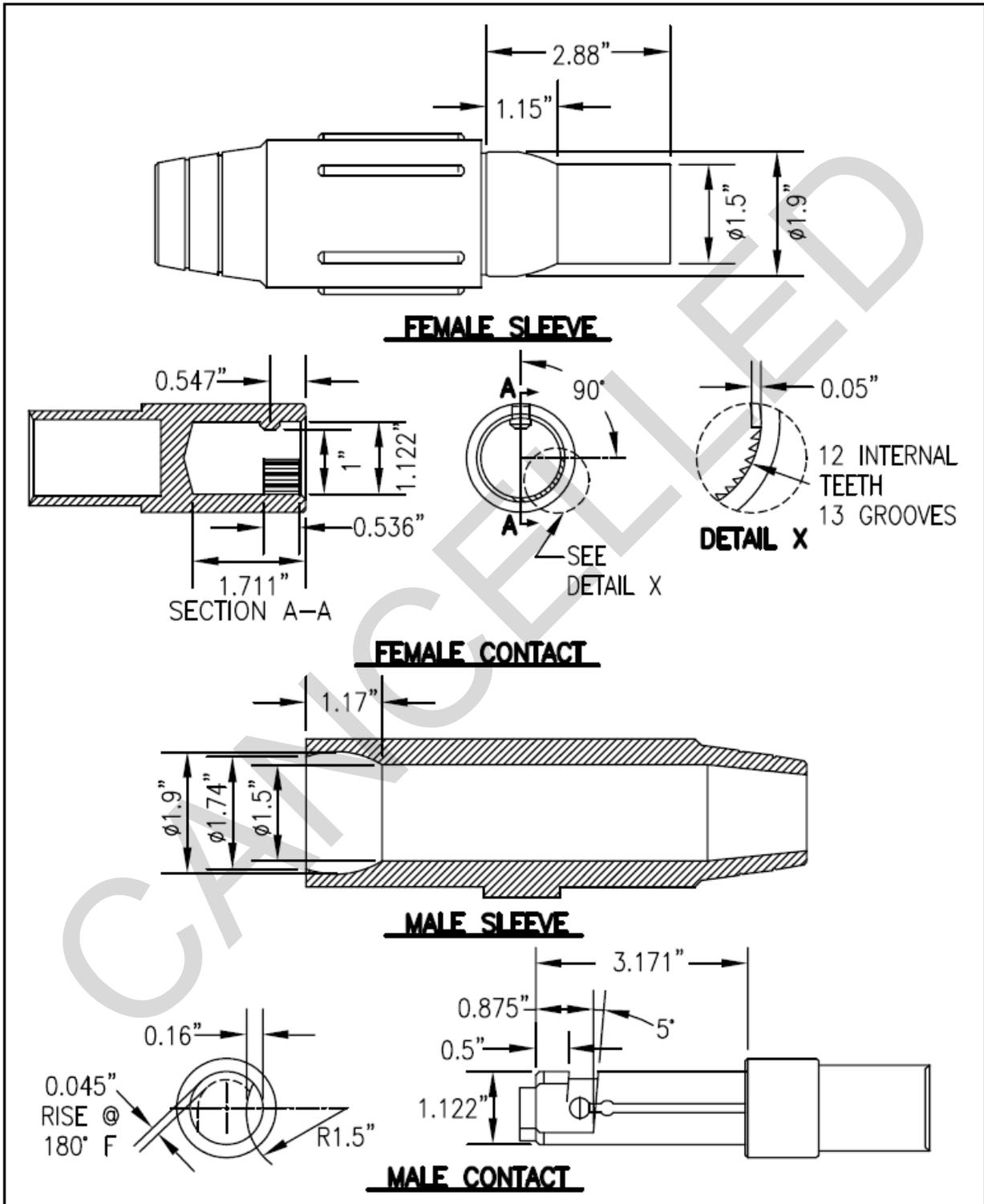


Figure F-5A Single Pole Connector Details



SINGLE POLE CONNECTOR DETAILS

**Figure F-5B Single Pole Connector Specification**

1. RATED FOR 600 VOLTS, 690 AMPERE MAX, 60 HERTZ, SINGLE POLE CAM, CONTINUOUS DUTY OPERATION.
2. INLINE CONNECTORS SHALL LOCK TOGETHER SO THAT THEY CAN NOT TWIST OR TURN LOOSE UNLESS A PUSH-BUTTON RELEASE MECHANISM IS ENGAGED.
3. POWER CABLE TERMINATION TO THE CONNECTOR CONTACTS SHALL BE VIA A CRIMP CONNECTOR.
4. THE INSULATED SLEEVES SHALL BE MECHANICALLY SECURED TO THE CONNECTOR CONTACTS TO GIVE A MINIMUM OF 700 LBS SHEAR FORCE.
5. BALL NOSE INSULATED SLEEVES SHALL BE MOLDED OF AN ETHYLENE PROPYLENE THERMOPLASTIC RUBBER (EPTR) COLORED BLACK PHASE A, WHITE PHASE B, AND RED PHASE C.
6. THE EPTR SLEEVES SHALL HAVE THE FOLLOWING MINIMUM REQUIREMENTS:
  - CONSTANT SERVICE TEMPERATURE RANGE:  $-60^{\circ}\text{C}$  TO  $+135^{\circ}\text{C}$  ( $-81^{\circ}\text{F}$  TO  $+275^{\circ}\text{F}$ )
  - FLAMMABILITY: UL 94 HB RATED
  - ELECTRICAL: UL RELATIVE THERMAL INDEX (RTI):  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ )

SINGLE POLE CONNECTOR SPECIFICATION

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ATTACHMENT 2-2.2

Figure F-6A Pier Electrical Distribution for Temporary Services (1 of 3)

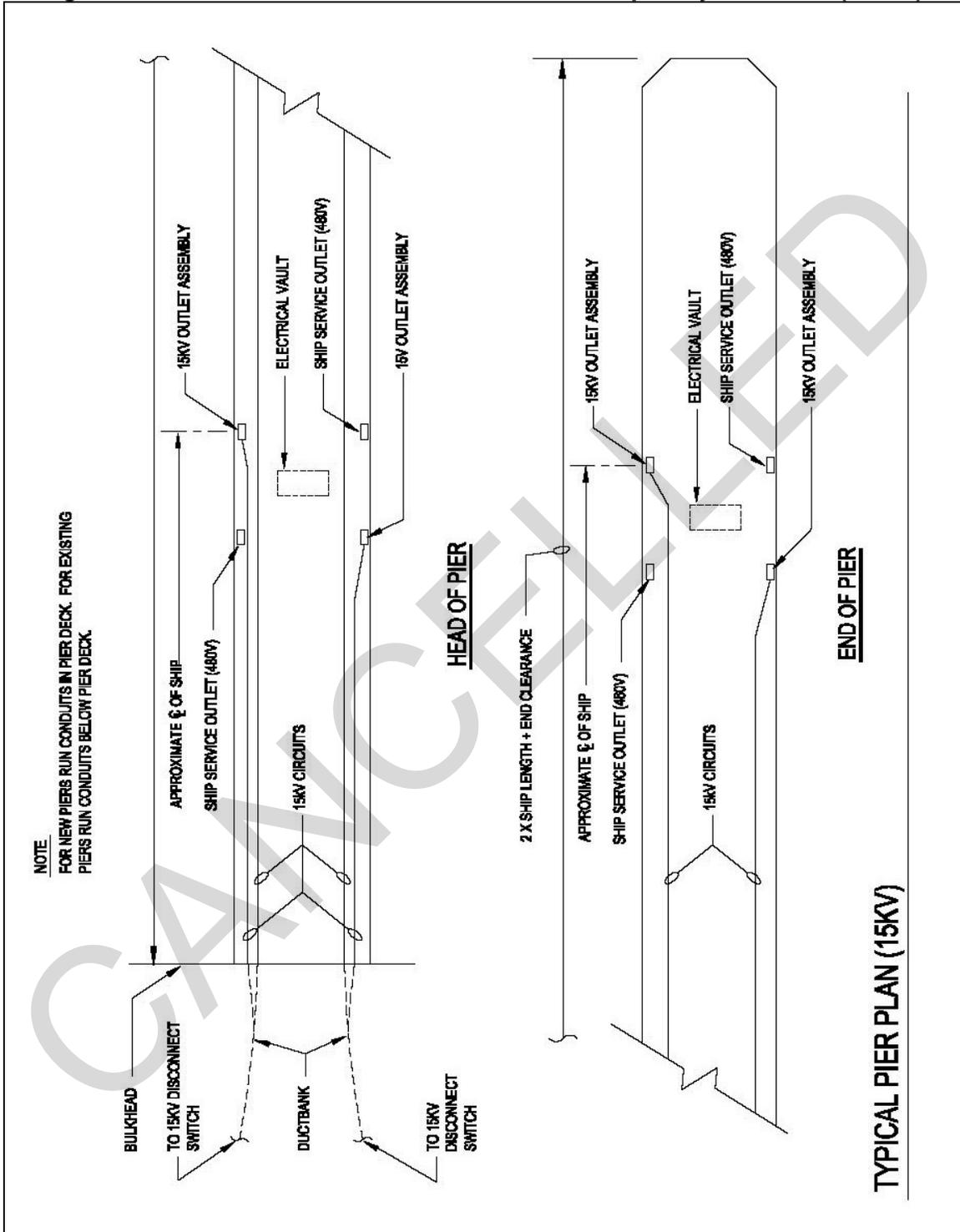


Figure F-6B Pier Electrical Distribution for Temporary Services (2 of 3)

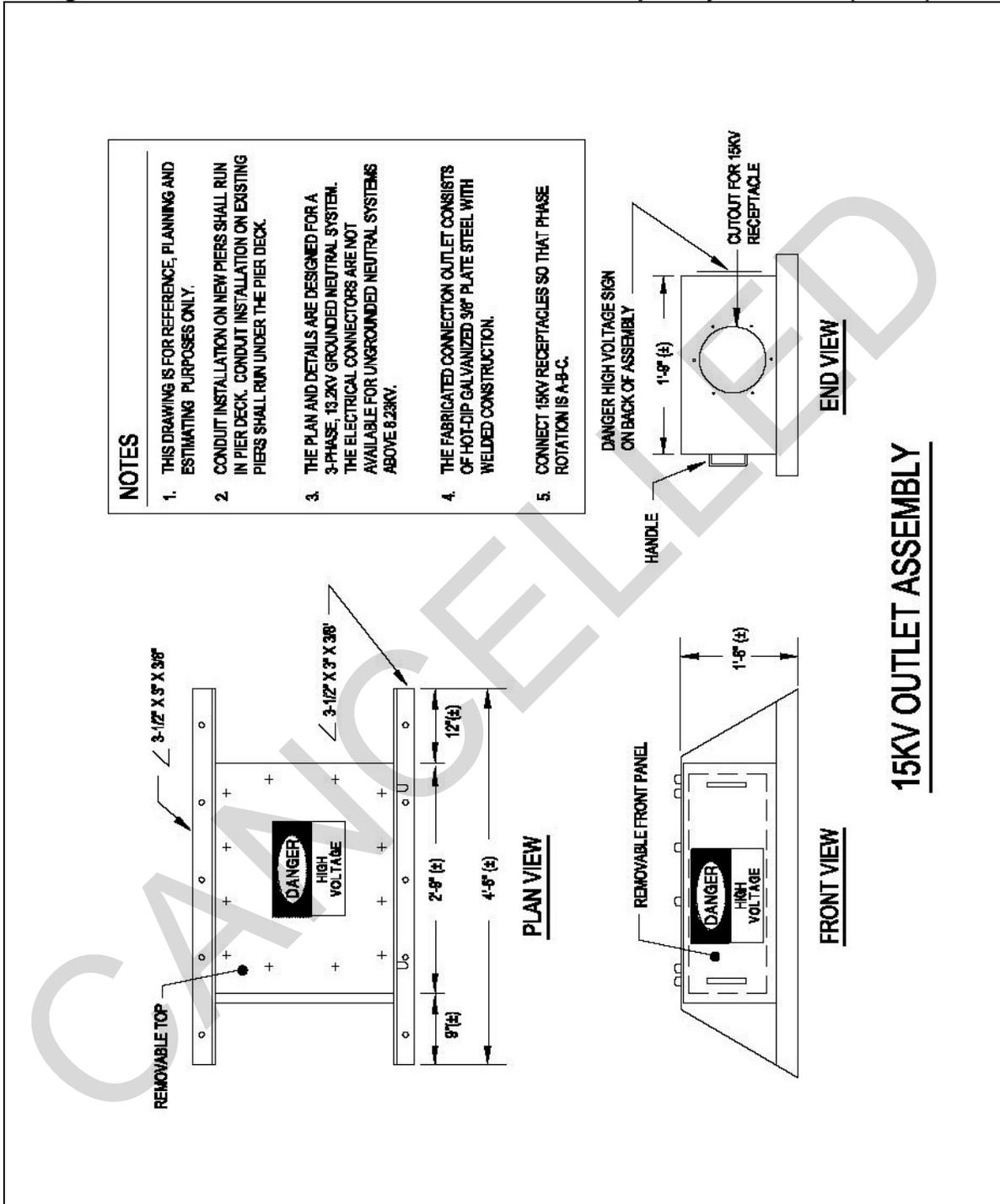


Figure F-6C Pier Electrical Distribution for Temporary Services (3 of 3)

